AD-A115 221 AIR FORCE WEAPONS LAB KIRTLAND AFB NM F/G 22/2

SIMULATION CODE FOR REENTRY VELOCITIES AND FLIGHT PATH ANGLES (--ETC(U)

JUL 79 L G JOHNSON

UNCLASSIFIED AFWL-TR-78-161 NL

1 OF 1

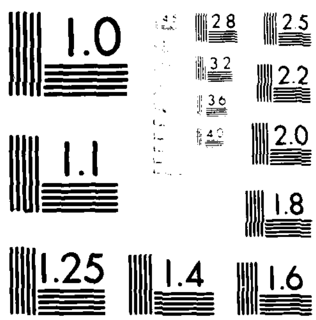
AD A

END

DATE FILMED

07-82

DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

AFWL-TR-78-161

(1)

AFWL-TR-
78-161

AD A115221

SIMULATION CODE FOR REENTRY VELOCITIES AND FLIGHT PATH ANGLES (V-GAMMA)

Capt L. G. Johnson

July 1979

Final Report

Approved for public release; distribution unlimited.

AIR FORCE WEAPONS LABORATORY
Air Force Systems Command
Kirtland Air Force Base, NM 87117

AFWL-TR-78-161

This final report was prepared by the Air Force Weapons Laboratory, Kirtland Air Force Base, New Mexico, under Program Element 62601F, Job Order 20070323. Capt L. G. Johnson (DYV) was the Laboratory Project Officer-in-charge.

This technical report has been reviewed and is approved for publication.

Lonnie G. Johnson

LONNIE G. JOHNSON
Capt, USAF
Project Officer

FOR THE COMMANDER

Terry A. Schmidt

TERRY A. SCHMIDT
Maj, USAF
Acting Chief, Environments and Effects Branch

Thomas W. Ciambrone

THOMAS W. CIAMBRONE
Col, USAF
Chief, Applied Physics Division

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER AFWL-TR-78-161	2. GOVT ACCESSION NO. AD-A115 221	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) SIMULATION CODE FOR REENTRY VELOCITIES AND FLIGHT PATH ANGLES (V-GAMMA)		5. TYPE OF REPORT & PERIOD COVERED Final Report 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Capt L. G. Johnson		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Air Force Weapons Laboratory (DYV) Kirtland Air Force Base, New Mexico, 87117		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 62601F, 20070323
11. CONTROLLING OFFICE NAME AND ADDRESS Air Force Weapons Laboratory (DYV) Kirtland Air Force Base, New Mexico, 87117		12. REPORT DATE July 1979 13. NUMBER OF PAGES 90
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Trajectories	Orbital Malfunction
Velocity	Reentry
Flight Path Angle	Nuclear Safety
V-GAMMA	Flight Simulations

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A computer code has been written which can simulate space vehicle trajectory changes. It was designed for use in assessing the range of reentry conditions and/or orbits which could result from system malfunctions. It gives parametric views of the reentry velocities and flight path angles and orbital lifetimes which may occur due to spacecraft engine operation. Operating conditions are specified over a range of engine burn durations, and initial conditions of location and orientation. This feature extends the applications of the code to include mission design studies and optimization.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

CONTENTS

SECTION I

INTRODUCTION

V-GAMMA is an orbital malfunction simulation computer code for space vehicles and is designed for use in assessing the range of atmospheric reentry conditions and/or orbits which can result from other than nominal mission trajectory changes. It gives parametric views of the reentry velocities and flight path angles and orbital lifetimes which may occur due to spacecraft engine operation over a range of conditions of initial location and orientation, and engine burn duration. This feature extends the applications of the code to include mission design studies and optimization.

The calculational methodologies employed are presented in reference 1. This technical report is a users manual and no attempt is made to represent supporting equations and derivations. However, particular sections of the original report are referenced frequently as a source of more in-depth information. Appendix A is a cross reference of variables used in the V-GAMMA computer code to the variables employed in reference 1.

Section II is concerned with the V-GAMMA code itself and Section III is concerned with SKETCH. SKETCH is a display code written to digest the output of V-GAMMA into a series of maps and charts. V-GAMMA outputs data using unformatted write statements onto a file named Tape 1 for input to SKETCH. The last section presents sample problems. Computer output for the sample problems is given in Appendix B.

1. Bailey-Souders, A Reentry Environments Velocity and Flight Path Angle (V-GAMMA) Calculational Methodology for General Space Vehicle Applications, AFWL-TR-74-244, Air Force Weapons Laboratory, Kirtland AFB NM, 1976.

SECTION II

V-GAMMA PROGRAM

ACCIDENT SCENARIOS

Of primary concern in initiating a V-GAMMA analysis is a definition of the accident scenarios to be considered. As defined in Section III of the AFWL-TR-74-244 there are three primary effects which, in general, are adequate to represent a malfunction:

Anomalous time of burn	Early burn No burn Late burn Nominal burn
Anomalous burn orientation	Random orientation Random within a specified range Preferred orientation Correct orientation
Anemalous burn duration	Nominal burn Short burn Extended burn or to depletion

Any of the above effects may be incorporated *individually or in combination* when representing a malfunction. Also available is the capability to treat subsequent burns and/or malfunctions. After a specified coast period any one or combination of the above effects may be reincorporated in the definition of a second burn.

When simulating accidents with specified subsequent burns, the code will look to treat secondary burns for only those cases which result in trajectories with perigees greater than 400 kft altitude and/or drift time to reentry greater than the nominal mission coast time to subsequent burn. Reentry is considered to occur at 400 kft.

Accident Probabilities

After the accident is postulated, one can then formulate its probability of occurrence. In general, this type of information is readily available for frequently used launch systems. However, if data are not available, some type of failure modes and effects study may be warranted Quite often, available

probabilities are presented in information defining idividual system component characteristics. In most cases, the failure of any one of several components may lead to a particular malfunction. For example, the failure of either an accelerometer or a digital computer may lead to a randomly oriented thrust vector. Therefore, when considering a malfunction the inverse of the product technique should be used to combine the individual component failure probabilities. On the other hand, if the accident being postulated is a combination of simultaneous malfunctions, the net accident probability is the product of the indivdual malfunction probabilities.

The code takes care of combining accident probabilities for sequential burn simulations. The burns are considered simultaneous events and their associated probabilities are appropriately combined.

Program Logic

The calculational methodology and logic flow employed in this code were given in Section VIII of reference 1 and will not be reproduced. However, a brief description of each subroutine and the main program is provided. Also provided are definitions of some key parameters with their counterpart symbols as employed in reference 1.

MAIN PROGRAM—V-GAMMA

The bulk of the program logic per the description given in Section VIII of reference 1 is located in the main program (V-GAMMA). The program is well commented. Loop control parameters for short burns, random orientation burns, and multiple burn locations can be readily identified and related to the V-GAMMA document.

Input and output control statements are also located in the main program. Accidents are inprocessed in block form by a call for subroutine ACCIN. ACCOUT prints a description of the accident to be treated in header form. This appears before the list of possible trajectories which could result from the burn malfunction. In general, when all of the possible cases of burn time, burn location, orientation, etc., are considered, a multitude of possible trajectories will result. Results of the individual burns are stored in blocks of 100 for outprocessing as a string. Those trajectories having perigees less than 400 kft are considered reentries and their descriptions include velocity, angle of attack, location, plus other critical parameters describing the reentry. Those trajectories which escape reentry will be either orbital decays or hyperbolic or

parabolic escapes. In this situation, a description of the resulting trajectory is given with the reentry parameters set equal to 0. Each of the resulting trajectories is assigned a probability of occurrence derived on an equal basis from the overall accident probability supplied as input data.

SUBROUTINES

ACCIN

ACCIN reads the input data blocks and assigns a subscript of 1 to the parameters describing the first burn. A subscript of 2 is assigned to those parameters describing the subsequent burn when they are included in the input data list. ACCIN is called once for each accident and the entire accident is inprocessed in block form.

ACCOUT

ACCOUT is called immediately after ACCIN to print the data just inprocessed to give a description of the accident being treated.

SELECT

SELECT is called by V-GAMMA at the beginning of an accident simulation sequence. Parameters defining the accident as read by ACCIN are accessed by SELECT and loaded into the calculational variables used by the main program, V-GAMMA. SELECT is recalled if the accident definition has indicated a subsequent burn. In this situation, subroutine FREEZE has already been accessed by V-GAMMA to store information necessary to restart the interation through the possible parameter variations of the primary burn after the second burn is specified by the input data and a variation of the primary burn does not result in a reentry trajectory.

UNIQUE

For accidents of random oriented thrust vectors within some predetermined solid angle, subroutine UNIQUE calculates the total number of unique orientations, NUMIS. NUMIS is used to calculate equal probabilities for the various orientations from the overall accident probability. This routine is also called for randomly oriented second burns.

BURN

BURN performs the pulsed burn iteration calculations. The inputs provided by the main program are the initial orbit and the vehicle location and thrust

vector orientation. Also provided are the vehicle's weight before and after the burn, thrust or the expected change in velocity, burn time and the number of burn pulses.

Velocity additions are simulated using pulsed burns rather than a single change in velocity at the point of burn initiation. By approximating the burn by a number of pulses with appropriate coast periods in between, the actual flight path and resulting location is more closely approximated. The burn simulation is stopped if a powered reentry occurs.

RENTRY

The primary function of RENTRY is to set the values of the variables in the output list describing the trajectory resulting from a burn simulation.

There are three entry points to the subroutine. They are BURNRE, YESRE and NORE.

Entry YESRE is accessed when it has been determined by V-GAMMA that the perigee of a calculated trajectory is less than 400 kft. YESRE computes the true anomaly of the reentry, its velocity, angle of attack, and other critical parameters.

Entry BURNRE is accessed when it has been determined that reentry occurred during a pulsed burn simulation. It computes the parameters describing the reentry as well as the amount of fuel remaining on board and the remaining burn time.

Entry NORE sets the output parameters describing a reentry equal to 0. This condition in the output list denotes a no reentry case.

VECTOR

VECTOR is a multipurpose vector manipulation routine. It has three entry points.

Entry VNORM—Given vector A, VNORM calculates C, the magnitude of A, the vector B, the normal of A.

Entry VDOT—Given vectors A and B, VDOT calculates C, the dot product A·B.

Entry VCROSS—Given vectors A and B, VCROSS calculates D, the cross product A X B.

NAXIS

Given the radial vector R, the constant C, and the vector K the unit vectors I and J which form the orthonormal, set I, J, K are calculated by the relations

$$I = R - C\,K$$
$$J = K \times I$$

NAXIS is employed in updating the vehicle's heading vector with changes in its location.

VTRAN

VTRAN computes the elements of the vector X in the equation

X (Transpose)*B = Y (Transpose)*T*B

where X and Y are vectors of length 3

T is a 3 x 3 transformation, natrix

and B is any three dimensional orthonormal basis

STORE

STORE stores relevant information describing the cases resulting from an accident simulation for output as a string by subroutine WDATA. The 17 variables describing a case are stored in blocks of 100.

WDATA

WDATA outputs information placed in the storage arrays by subroutine STORE. The results of the analysis are output to Tape 6 (output file) and Tape 1 (data tape used as input to program SKETCH). Data is placed on Tape 1 using unformatted write statements.

STATUS

STATUS keeps account of central processor time consumption and provides this information at the end of the output list.

LDRIFT

LDRIFT calculates a new true anomaly Y from an initial position X after drifting in an orbit for T seconds.

TDRIFT

Calculates the drift time in seconds required to drift from location X to location Y in a given trajectory. X and Y are in radians. The drift time, T, is always positive. The true anomalies X and Y determine the direction of travel. The positions supplied to this routine always represent clockwise motion. Therefore, negative drift times are never requested.

F (X,E)

Calculates the indefinite integral of DX / (1.+E*COS(X))**2 for use in trajectory transit time calculations. X is the true anomaly in radians and E is eccentricity.

FREEZE

A subroutine for storing all parameters associated with a variation of the main burn which does not result in reentry and is to be followed by a sequential burn simulation.

Entry START—This part of the subroutine stores all parameters defining the first burn so that calculations can be restarted at an appropriate location in the iteration after simulations of the second burn have been completed. It also calculates a true anomaly for the second burn based on the between burn coast period supplied as input data.

Entry STOP—This portion of the subroutine is called after all iterations of the subsequent simulation have been completed. It restores the program to the conditions which existed before the initiation of the subsequent burn simulation.

ZEROIN

ZEROIN is called by LDRIFT when performing trajectory drift calculations. ZEROIN is a numerical convergence routine and is used in Newton's method for calculating the position of an orbiting or escaping vehicle after a specified coast period from some initial location. Given a function, F(X), and two points, AX and BX, such that F(AX) and F(BX) have opposite signs, ZEROIN computes an X between AX and BX such that F(X) = 0.0, to within an accuracy specified by TOL.

ACCIDENT INPUT DATA

The first data card read is the overall title of the analysis being performed. It is followed by a card giving the total number of data blocks describing accidents.

The data blocks follow in sequence. Each data block should present critical burn parameters completely describing the burn which would occur as a result of the postulated malfunction(s). The following listing describes the sequence in which the data cards should appear, and includes the card number, the format, and the required data. Figure 1 shows the sequence in graphic form at the end of the listing.

Card No.	Format	Parameters	
1	8A10	Title	Title of overall analysis, 80 alphanumeric parameter field
2	I5	NADB	Total number of accidents in the data set.

The following data block is repeated NADB times, describing each accident being treated:

3	2I5	NACC	Number of this data block in the NADB block sequence. NACC identifies the data blocks in increasing order from 1 to NADB.
		NSUBB	Identifies this accident as having a subsequent burn. This version of V-GAMMA can treat only one subsequent burn. So NSUBB will be 0 or 1.
4	13A6,A2	Title	Title of the individual accident, 80 alphanumeric parameter field.
5	F20.10	PROBIN	Probability that the accident described in this data block will occur.
6	2F10.5	PERIN	Perigee of the initial trajectory.
		APOIN	Apogee of the initial trajectory if the trajectory is an ellipse. If the trajectory is other than an ellipse, the eccentricity should be given instead. (Altitudes are in nautical miles above earth radius).
7	3F10.5	HVIN(3)	Vehicle heading vector at location of burn. The heading vector is computed from the yaw and pitch by use of the following transformation:

Card	Format	Variable	Description
		HVIN	H_1 = sin a cos b 0 0 I H_2 = 0 sin b 0 J H_3 = 0 0 cos a cos b K where a is the pitch and b is the yaw. For more detailed description see section V of reference 1.
8	2F10.5	W1IN	Initial weight of the vehicle.
		W2IN	Final weight of the vehicle. The difference in W1IN and W2IN represents the fuel consumed by the engines during the burn (pounds).
9	F10.5	TCIN	If a sequential burn is to be treated after the burn being described, TCIN represents the coast time between burns. Otherwise, TCIN is supplied as 0 (seconds).
10	2I5,5X 3F10.5	NBL	NBL is used in situations where it is desirable to treat a series of shorter than nominal burns. If NBL is specified as greater than 1, then the burn specified by the input will be treated with equal probability of having NBL different burn lengths. Specifically, If T is indicated burn time then in the X^{th} iteration the burn time is: $T_X = T/NBL * X$ where $1 \leq X \leq NBL$
		NIN	The burn specified in the input is divided into NIN pulse burn iterations to more closely approximate the actual path of the vehicle during the burn.
		DTIN	The net burn duration is seconds.
		THRUST	Vehicle thrust (lbs). This parameter is not necessary if a velocity change, DVIN, has been specified.
11	2F10.5,I5	T1IN	True anomaly of the burn (°).
		T2IN	For situations in which it is desirable to treat a series of possible burn locations. T1IN

			and T2IN specify the range of true anomalies to be considered. Otherwise set T2IN = T1IN.
		NTIN	V-GAMMA will treat NTIN possible locations within the T1IN to T2IN range with equal probabilities of occurrence. For a single burn at the indicated location set NTIN = 1.
12	3F10.5	P1IN & P2IN	Sets the upper and lower limits, respectively, in the pitch plane of the solid angle defining the range within which the vehicles heading vectors can vary when simulating a series of random orientation burns. The P1IN and P2IN angles are input in degrees relative to the previously specified heading vector. The pitch plane is formed by the radius vectors and vehicle velocity vector.
		DPIN	The random orientations will be considered to occur with equal probability in increments of DPIN (°) in the pitch plane between the P1IN and P2IN angles.
13	3F10.5	Y1IN	Y1IN and Y2IN sets the maximum and minimum limits in the yaw plane. See reference 1 for detailed definitions of pitch and yaw angles.
		Y2IN	And Y2IN sets the limits of the solid angle defining the range within which the vehicle's heading vectors can vary when simulating a series of random orientation burns. Y1IN and Y2IN are input in degrees relative to the previously specified heading vector.
		DYIN	The random orientations will be considered to occur with equal probability in increments of DYIN (°) in the yaw plane between the Y1IN and Y2IN angles. Zero yaw specifies the pitch plane of the heading vector.

The following cards are included as a part of the data deck if NSUBB is equal to 1, indicating that a subsequent burn will take place.

14	A80	Title (2)	Title of subsequent burn.
15	F20.10	PROBIN(2)	Probability that burn will occur.
16	2F10.5	W1IN	Weight of vehicle before burn.
		W2IN	Weight of vehicle after burn.
17	2I5, 5X, 2F10.5	NBL(2)	See data card 10.
		IVIN	See data card 10.
		OVIN	See data card 10.
		DTIN	See data card 10.
18	3F10.5	P1IN	See data card 12.
		P2IN	See data card 12.
		DPIN	See data card 12.
19	3F10.5	Y1IN	See data card 13.
		Y2IN	See data card 13.
		DYIN	See data card 13.
20	3F10.5	HSEQ	

A sequential malfunction can assume either a full or partial failure of the inertial guidance system. This read statement allows the flexibility to simulate the sequential malfunction to any degree of inertial guidance failure. If HSEQ is input as 0I + 0J + 0K subroutine FREEZE will assume a complete guidance system failure and calculate the heading vector, assuming a spatially fixed heading vector at the end of the first malfunction burn. If HSEQ is inputted other than 0I + 0J + 0K this inputted value will be used as the heading vector in the sequential malfunction calculations. See data card description 7 for more input details. Note that if random orientations are specified by data cards 15, 16, and 17 the orientations are taken about the subsequent heading vector as described previously.

The above described data cards beginning with 3 represent one data block. here should be NADB data blocks, one for each of the accidents to be treated.

V-GAMMA OUTPUT

As discussed previously, many malfunctions can result in a multitude of possible trajectories. The V-GAMMA output consists of a list of descriptions, each set describing a trajectory which could result from the specified accident. Each description on the list will define the following varíales.

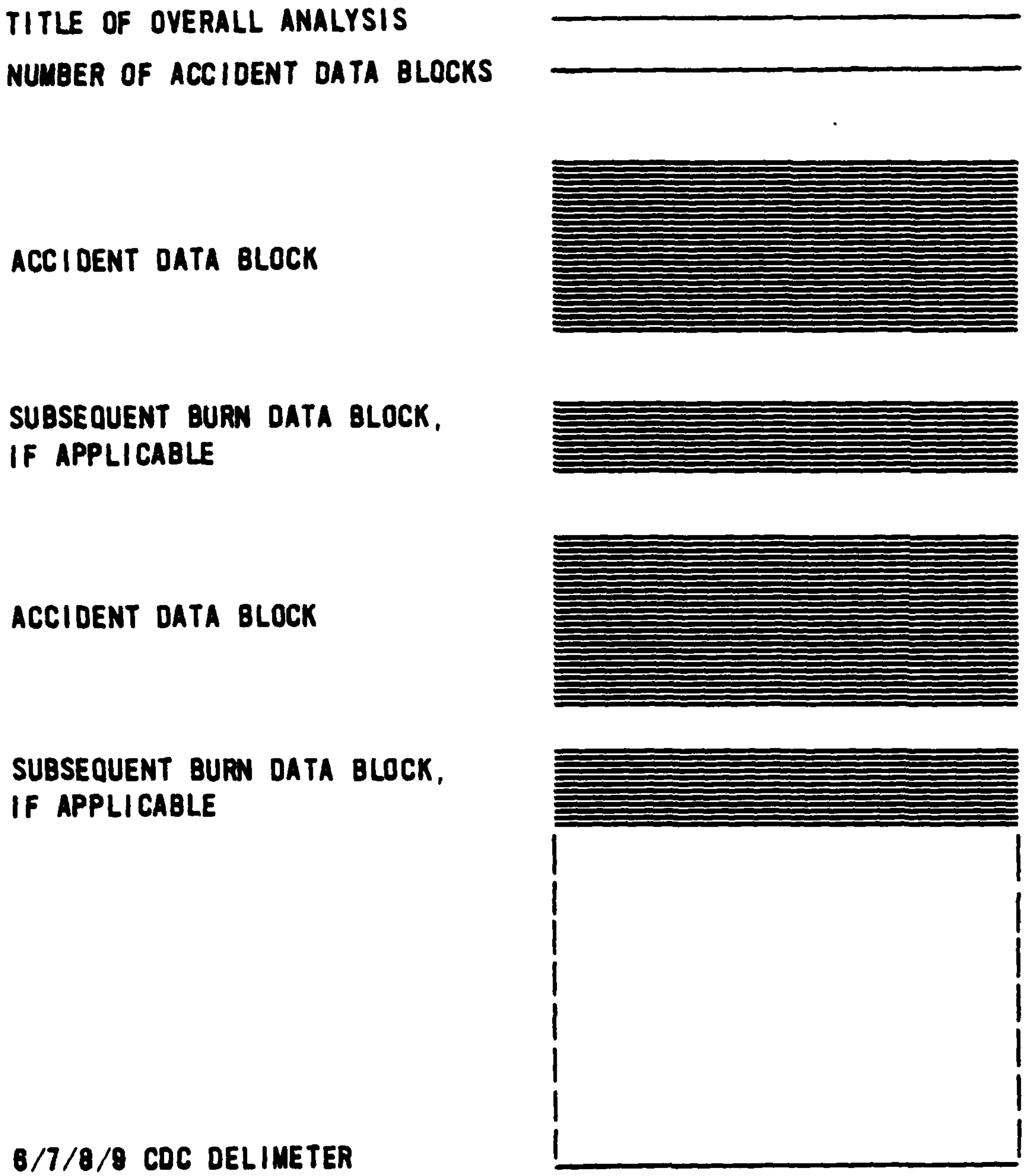


Figure 1. Sequence of Data Cards

LEVEL	-	Flag indicating whether description refers to a primary or secondary burn.
THETA	-	Anomaly at which malfunction is initiated.
PITCH	-	Initial orientation of the vehicle in the pitch plane formed by the radius vector and the vehicle velocity vector. The pitch angle is relative to the vehicle velocity vector (degrees).
YAW	-	Initial vehicle orientation relative to the pitch plane.
P	-	P = PRG*(1+E)Similatus Rectum of the trajectory at burn termination
PRG	-	Perigee of the resulting trajectory
E	-	Eccentricity of the resulting trajectory
H	-	H = P * G * EM Constant of angular momentum of the trajectory EM earth mass G universal constant of gravitation
T	-	True anomaly at burn termination
GEOP	-	Geocentric perigee of the resulting trajectory
THETAC	-	True anomaly of reentry
VC	-	Vehicle velocity at point of reentry (kft/s)
GAMMA	-	Flight path angle at point of reentry (degrees)
ALPHAH	-	Defines vehicle orientation or angle of attack of reentry. ALPHAH is the angle between the vehicle velocity vector and its heading vector and lying in the orbital plane (degrees).
BETAH	-	The slip angle between the vehicle heading vector and the orbital plane (degrees).
TRE	-	Time (seconds) from malfunction initiation to reentry
WFRE	-	The amount of fuel (lbs) remaining onboard for those cases resulting in powered reentry
EVPROB	-	Probability that this event or case will result from the defined malfunction

SECTION III

SKETCH DISPLAY CODE

SKETCH is a program written to condense the output of V-GAMMA into a set of tables and charts called V-GAMMA maps. The program can be divided into two parts: (1) a set of mapping routines which generate the various tables and charts described previously and (2) a set of routines responsible for orbital lifetime predictions. These two parts are discussed in the first two paragraphs of this section, the third and fourth paragraphs give detailed descriptions of input and output. The capabilities of the code are described in the paragraph defining the input parameters. It should become obvious from the beginning of that paragraph that SKETCH will allow the user considerable amounts of flexibility both in selecting accidents for review from the overall V-GAMMA output and in considering specific cases from those accidents.

MAIN PROGRAM SKETCH

SKETCH contains the logic necessary to make decisions and call appropriate subroutines based on data appearing on the V-GAMMA output tape and the specific V-GAMMA maps, charts, and tables requested by the input data cards.

SUBROUTINES

ZERO

This subroutine zeros the various storage and plotting arrays. It is called initially at the beginning of the analysis to zero all arrays and once after each accident data block to zero those which are used to generate charts and tables that are specific to the individual accidents. Those arrays used to generate summary information are not zeroed after the initial call to this subroutine.

DECAY

DECAY is called by SKETCH when an orbital trajectory is being processed. DECAY in turn calls those subroutines necessary to compute an orbital lifetime for the trajectory. As discussed in the first paragraph of this section, two methods are available for orbital decay prediction. For long lifetimes (greater than 30 years) a three-dimensional (3-D) spline interpolation routine is used.

For shorter lifetimes, L. L. Perini's orbital decay program is used directly (ref. 2). DECAY determines which method should be used, calls the appropriate subroutine, then calls subroutine PRINT to store the results.

LIFE

LIFE is an orbital lifetime prediction program. The program performs an orbit by orbit iteration decreasing each orbit by the appropriate amount based on atmospheric drag. In keeping track of the elapsed orbital time, LIFE indexes KTO (the Zurich support number indicator) by the appropriate amount in order to take into account changes in the atmospheric density.

The numerical procedure employed in the analysis is based on the development presented by King-Hele (ref. 3). The assumptions employed are as follows:

1. The atmosphere is spherically symmetrical.
2. Air density varies exponentially with height.
3. Lunar-solar perturbations are neglected.
4. The only nonconservative force considered is air drag and it acts in a direction tangent to the orbital plane; i.e., normal forces are neglected.
5. During one revolution, the action of air drag changes the orbit by a small amount, where squares can be neglected.
6. The unperturbed orbit is an exact ellipse.
7. The atmosphere rotates with constant angular velocity.
8. The atmospheric density does not vary with time. This assumption is involved in the derivation of the equations of motion; however, long term variations are considered in a corrective manner by reevaluation of the density scale height.

ATM

ATM is essentially a model of the Jacchia atmosphere (ref. 4) modified to be consistent with the assumptions given in the description of subroutine LIFE.

---

2. Perini, L. L., Orbital Lifetime Estimates, John Hopkins Applied Physics Lab, ANSP-M-8, 1974.
3. King-Hele, D., Theory of Satellite Orbits in an Atmosphere, Butterworths, Inc. Wash D C, 1964.
4. Jacchia, L. G., "Revised Static Models of the Thermosphere and Exosphere with Empirical Temperature Profiles," Special Report SR-332, Smithsonian Astrophysical Observatory, 1971.

Those phenomena which can cause time variation in atmospheric density are:

1. Variations with the solar cycle.
2. Variations with the daily change in activity on the solar disk.
3. The diurnal variation.
4. Variation with geomagnetic activity.
5. The semiannual variation.
6. Seasonal-latitudinal variations of the lower thermosphere.
7. Seasonal-latitudinal variations of helium.
8. Rapid density fluctuations probably connected with gravity waves.

The above variations are in general short term with the exception of those due to changes during the solar cycle. Short term effects are neglected in this model because of computer time requirements. For this reason, predictions shorter than 10 years are not expected to be very accurate. This point is discussed in reference 2 in more detail.

ATM also calculates and makes modifications to the density scale height (H). This parameter is used to account for changes in air density a space vehicle would encounter as it progresses through an elliptical orbit.

PRNTLF

PRNTLF is called by subroutine PRINT once for every 100 orbital lifetime predictions. For each of the 100 orbital trajectories subroutine PRINT prints the initial vehicle orientation conditions, the critical parameters describing the orbit, the predicted orbital lifetime, and the probability of occurrence assigned to the trajectory.

STATUS

This subroutine generates a summary table for each accident data block. The tables give the frequencies and probabilities for resulting elliptical, parabolic, and hyperbolic trajectories with breakouts detailing reentries, escapes, and orbital decays. If THETAC is specified, STATUS summarizes the data generated for a particular theta throughout the accident block.

MODVG

MODVG is a numerical manipulation routine which modifies the entries of the V-GAMMA frequency of occurrence maps to be less than 1000 for plotting under

I3 format. A scale factor is included in the title of the frequency maps which, when applied to the number appearing in the V-GAMMA space, yields actual frequency of reentries.

FMAP

This subroutine generates the frequency of occurrence V-GAMMA maps. Similar to subroutine PMAP, subroutine FMAP plots a set of two maps for each accident simulation. One map shows all reentries and the other shows those which are powered. A set of overall reentry maps displaying all reentries resulting from the vairous accidents analyzed is provided along with the overall probability maps.

NUMEXP

NUMEXP is a numerical manipulation routine which evaluates the leading integer (rounded off) and power of 10 exponent from reentry probabilities for entry into the V-GAMMA reentry velocity and flight path angle probability maps.

PMAP(K)

This subroutine generates the probabilities V-GAMMA maps. A set of two maps is generated for each accident. One map shows all reentries. Reentries which occur with the vehicle engines still burning are also displayed in a second V-GAMMA map entitled: Powered Reentries, this second map will not appear in the output list. A set of overall V-GAMMA maps is also generated displaying all reentries for the complete set of accidents analyzed.

CHART

CHART generates a set of summary tables giving the results of each individual accident simulation. It is called by SKETCH as data are processed from the V-GAMMA output tape. There are several entries to this subroutine.

ENTRIES

ONE

This segment of the subroutine stores data into the matrix for the frequency charts that depict the time to reentry from malfunction and burn time remaining for powered reentry.

TWO

TWO generates reentry time charts depicting the frequency data stored into the reentry time matrix by ENTRY ONE.

THREE

This segment generates the matrix that is used to produce the frequency charts summarizing the vehicle orientation at reentry relative to its velocity vector.

FOUR

This entry produces the charts that depict the frequency of reentry orientations matrix established by ENTRY THREE.

FIVE

FIVE sets up an array of probabilities versus orbital reentry times. Data are simultaneously stored into the arrays. One contains information relative only to the current data block being processed from the V-GAMMA output tape by SKETCH. The other is a summary storage array for all accidents considered.

SIX

SIX uses the array established by ENTRY FIVE to generate an orbital lifetime probability distribution chart for each accident simulation.

SEVEN

SEVEN is called by SKETCH just prior to run termination to generate an overall orbital lifetime distribution chart summarizing the results of all of the accidents extracted from the V-GAMMA output tape.

SUBROUTINES

PRINT

PRINT generates frequency plots showing the distribution of orbital lifetimes. It is called by subroutine DECAY for storage of each orbital lifetime calculated. With the completion of each accident simulation, SKETCH calls subroutine PRINT for the resulting distribution of orbital lifetimes. SKETCH makes a final call to PRINT just prior to job termination for a combined lifetime distribution graph of all accidents simulated.

SPLNI3D

SPLNI3D is called by subroutine DECAY for lifetime predictions for those orbits expected to last more than 30 years. SPLNI3D interpolates decay time from data tables located near the beginning of SKETCH as follows:

Given a tabular set of data

((X(I),Y(J),Z(I,J)) I=1,...,NX J=1,...,NY)

that describes a functional relationship between the independent variables, X and Y, and the dependent variable, Z, SPLNI3D uses cubic splines to interpolate for the value of the function, the values of the first partial derivatives, and the values of the second partial derivatives for specified values of the independent variables.

ORBITAL LIFETIME METHODOLOGY

The methodology employed in SKETCH for predicting orbital lifetimes is based on a computer model developed by L. L. Perini.

To verify the accuracy of his code, Perini ran several check cases for a series of orbital lifetimes without the solar effect, using tabular values of the 1962 standard atmosphere, for which lifetime solutions are available based on complete numerical solutions (TMX-53385, 1966, NASA). The resulting comparison showed excellent agreement, with a maximum difference of about 8 percent.

A mean solar cycle model based on the averages of cycles 8 to 19 was incorporated in the code (ref. 4). The results led to the following conclusions:

a. With the mean solar cycle as a basis, lifetimes are three to four times longer than would be predicted using the 1962 standard atmosphere.

b. A 1σ deviation of the solar cycle from the mean value can affect the lifetime of a factor of 1.5.

c. For lifetimes greater than 30 years, estimates based on a nontime-varying, reference value exospheric temperature derived from a value of reference density that is time-averaged over the mean solar cycle agree well with more exact calculations that directly considered the mean time-varying solar activity.

d. For long lifetimes (> 30 yrs) the lifetime is directly proportional to the ballistic coefficient.

e. For long lifetimes (> 30 yrs) the lifetime estimate is independent of where on the solar cycle the calculations are begun.

Although the objective of this work was to provide more realistic (rapid) estimates of orbital lifetimes by accounting for solar effects, no comparisons with experimental data can yet be made because of the long lifetimes under

consideration. The major uncertainty is the solar cycle model, for which it has been assumed implicitly that the mean of future cycles will be represented by the mean value of past data.

Based on the above generalizations, the lifetime code was used to generate a set of tables of Orbital Lifetime/Ballistic Coefficient versus Perigee and Eccentricity for use in a cubic spline numerical interpolation and differentiation routine. Predictions of orbital lifetimes for the extremely high altitude orbits encountered in safety analysis were too time-consuming for efficient use in V-GAMMA. However, these generalizations are only applied to orbits with expected lifetimes greater than 30 years. For shorter decay times, Perini's code is incorporated directly.

A necessary input into the code is the period within the solar cycle at which the decay is to be initiated. The period of initiation is known by the computer code as KTO. A graph of the Zurich sunspot number versus time into the solar cycle is included for the purpose of evaluating KTO (figure 2). Of primary concern is the continuous curve which represents the mean of cycles 8 to 19. The dependence of the lifetime estimates on solar activity is based on this mean. Each of the 11 years of the cycle is divided into quarters so that KTO can range from 1 to 44 identifying the particular quarter of the year in which the calculations are to be initiated. KTO is evaluated by superimposing the current 11 year period onto the graph. This is done simply by adding some multiple of 11 years to the October 1964 date such that the date that the decay is expected to be initiated will fall into the 11-year period. KTO corresponding to the quarter containing that date is obtained directly.

SKETCH INPUT DATA

The input parameters to SKETCH are primarily control variables for the various plotting and mapping routines. Through the correct use of these control variables, the data tape (Tape 1) can be scanned for particular data sets or for individual cases of interest. The exceptions to this generalization are those parameters employed in orbital lifetime predictions.

Input data should be supplied to SKETCH in the following sequence and format:

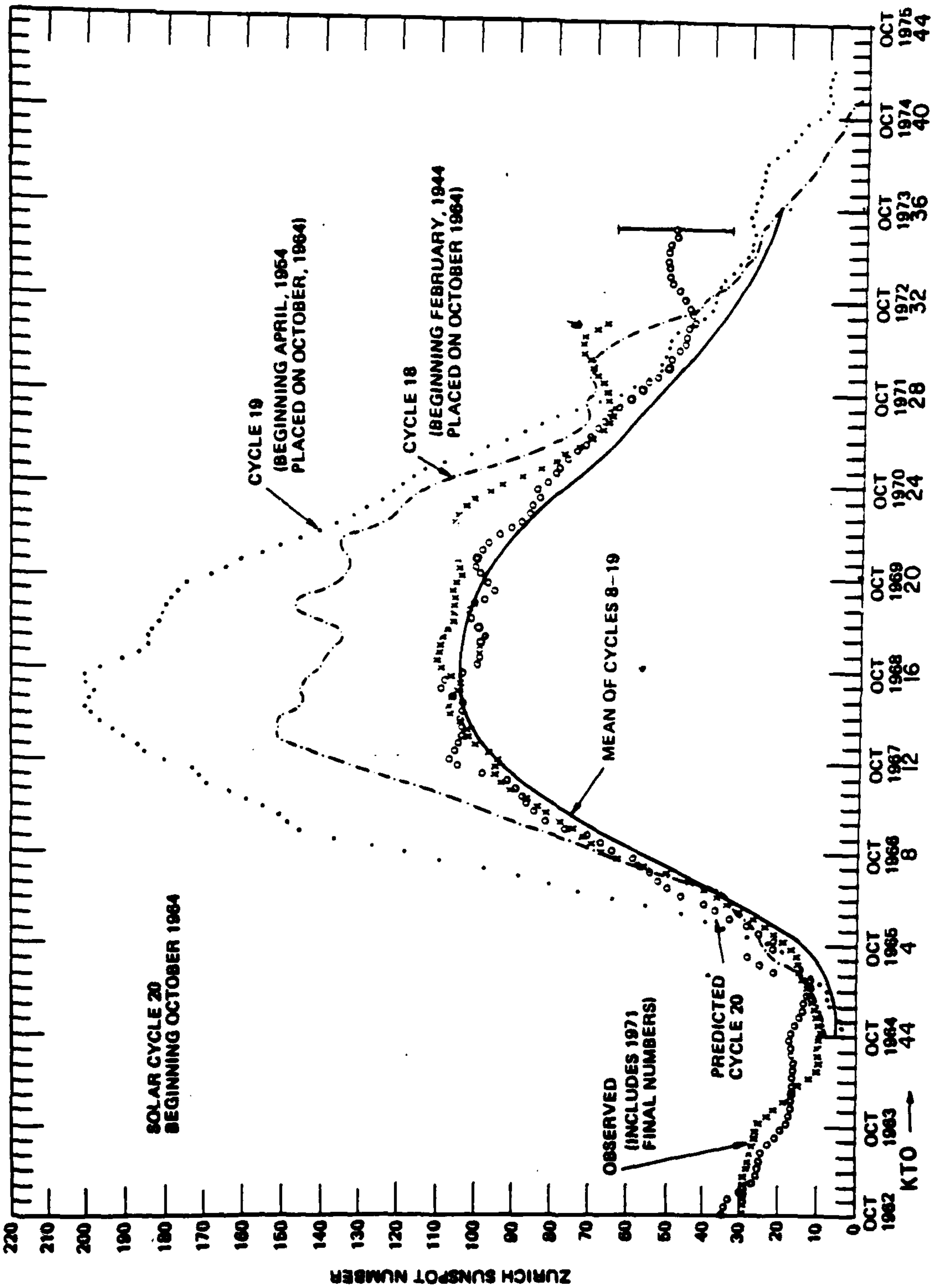


Figure 2. Predicted and Observed Sunspot Numbers with Indicated Period (KTO) for Computer Cude Input

Card No.	Format	Parameters	
1	(A80)	Title 1	The overall title of the V-GAMMA analysis 80 alphanumeric fields.
2	(I5)	KTO	Index for Zurich Sun Spot No. See section on Orbital Lifetime Methodology for estimating this value.

The following data block is repeated as often as necessary to derive the desired summary charts and maps from Tape 1.

Card No.	Format	Parameters	
1	(A80)	Title	Title of individual accident or case to be extracted from Tape 1.
2	(F10.4, 2I5)	BALL	Ballistic coefficient of satellite configuration after the malfunction.
		IC	Sequential accident flag. IC = 1. May or may not be sequential malfunctions on the data files of Tape 1 but extract only the results of primary burns. IC = 2. Definitely sequential burn simulations on data file of Tape 1 and both will be extracted.
		IB	Level of accident to be extracted by the present data set. IB = 1. Primary accident. IB = 2. Secondary or sequential accident. NOTE: Results of Primary and Secondary burn simulations for a single accident should be extracted in sequence.
3	(I5, 5X, 3F10.5)	IFILE	The number of the file on Tape 1 which contains the data set to be treated by this data block. Each accident is entered on Tape 1 as a separate file. The accidents occur in the same sequence that the data were input to V-GAMMA. The output data file number can be identified as the sequence number input as a part of the V-GAMMA input data. Data resulting from a subsequent burn are placed on the same file as the primary.
		THETAC	The maximum value of true anomaly for selecting cases from the data tape (Tape 1). This parameter is used to screen for certain anomalies when extracting data from Tape 1. If 0 < THETAC < 360 only the accidents occurring at true anomalies less than THETAC are extracted. If all cases are to be considered, then set THETAC equal to 370.

		PITCHC	Only cases occurring at orientations with pitch equal to PITCHC will be extracted from the data tape. If all pitch orientations on the data tape are to be extracted then set PITCHC equal to 370.
		YAWC	Only cases YAW equal to YAWC will be extracted from the data tape. If all YAW orientations on the data tape are to be extracted then set PITCHC equal to 370.
4	(4I5)	ITYPE(1)	A value of 1 for this parameter indicates to SKETCH that frequency V-GAMMA maps should be generated.
		ITYPE(2)	A value of 1 indicates that frequency V-GAMMA maps for powered reentries should be generated.
		ITYPE(3)	A value of 1 indicates that probability V-GAMMA maps should be generated.
		ITYPE(4)	A value of 1 indicates that probability V-GAMMA maps should be generated for powered reentries.
5	F10.5	BURNT	Total vehicle burn time. This parameter is used to compute the remaining burn time for powered reentries.
6	6F10.5		The following parameters determine the size and scale range of the V-GAMMA maps. It may be necessary to derive the scale limits through trial and error in order to obtain maps most representative of the analysis.
			VMIN - Minimum velocity for the velocity scale of the V-GAMMA maps.
			VMAX - Maximum velocity for the velocity scale of the V-GAMMA maps.
			VCW - Channel width or scale increments for the velocity scale.
			VMIN, VMAX and VCW should be selected to give a maximum of 24 channels. This number would fill a standard size computer page of 136 characters horizontally. The units of the velocity inputs should be kft/s.
			GMIN - Minimum reentry angle for the gamma scale of the V-GAMMA maps.
			GMAX - Maximum reentry angle for the gamma scale of the V-GAMMA maps.
			GCW - Channel width or scale increments for the gamma scale.

GMIN, GMAX and GCW should be selected for a maximum of 45 channels. This would vertically fill a standard size printer page of 64 lines with space included for a title and scale tables.

SKETCH OUTPUT

The V-GAMMA maps begin with the accident definition. The accident may be due to any one or combination of the following malfunctions: abnormal length of burn; abnormal time of burn, and misorientation of thrust vector.

Any single malfunction or combination of the malfunctions will have an associated probability of occurrence. It is often desirable to specify accidents which may occur over a range of burn lengths, locations, and/or orientations. In this situation, the probability of occurrence is distributed equally over the specified range(s). All accident iterations which result in a reentry at a given velocity and flight path angle will have their associated probabilities combined and placed in the indicated V-GAMMA block. Probabilities on the V-GAMMA maps are read as a multiplier times an exponent of 10. For example, 2-6 is read as 2×10^{-6}.

Also, generated are frequency maps. These maps indicate the total number of reentries occurring at a given velocity and angle of attack. Those cases resulting in powered reentries are extracted from the overall frequency and probability maps and displayed in a separate set. In addition to the information described above, the following is provided as a set of summary tables.

a. Maximum and minimum velocity and angle of attack summary of points outside of the range selected for the maps (summary of off-scale points).

b. Maximum and minimum velocity and angle of attack summary of on-scale points.

c. A breakdown of the quantity and types of trajectories resulting from the accidents; given is the number of trajectories which fall into the elliptic, parabolic, and hyperbolic categories. Those trajectories with perigees less than 400 kft are considered reentries. A summary is given for each trajectory type telling how many reentries occurred, and of those, the number which are powered. It should be noted that the total number of elliptical escapes actually defines the number of elliptical orbits with perigees greater than the atmospheric capture altitude of 400 kft. These trajectories result in orbital decays.

d. A chart giving the frequency of reentry times with breakdowns of time from malfunction to atmospheric capture and remaining burn time for powered reentries.

e. A chart giving the frequency of vehicle orientation at reentry with a summary of the number occurring end-on, side-on, and head-on.

f. A chart giving the probability of orbital decay times with breakdowns in hours, days, months, years, and centuries. An orbital lifetime distribution in graphic form presents probability of reentry as a function of time after the accident. This latter output is the result of an orbital decay model developed by L. L. Perini. It gives good orbital lifetime predictions and is based on the 1971 Jacchia atmospheric model.

g. A set of overall summary maps is located at the end of the output list. These maps represent the total of frequencies, probabilities, and lifetime distributions of all accidents analyzed.

SECTION IV

SAMPLE PROBLEMS

V-GAMMA SAMPLE INPUT

The following sample problems should give some additional insight on the use and applications of the V-GAMMA computer code. These simulations were selected from the safety analysis performed for the 1977 Voyager-Jupiter-Saturn fly-by mission. The nominal mission profile called for two engine burns after an initial orbit was achieved. The first was a second burn of the Centaur liquid propellant booster, and the second was a burn to depletion of the solid propellant propulsion module.

The accident scenarios present a description of the accident along with the vehicle burn and trajectory parameters, followed by listing (figure 3) showing the data cards required to input the described accident. The V-GAMMA output for the described accident is presented in appendix B. A detailed description of the output which the code generates is given in the paragraph entitled *V-GAMMA Output (section II)*.

The output generated by V-GAMMA and SKETCH for the sample problems is given in appendix B. A system dayfile listing is also in appendix B. It is included as an aid to the user in setting up the V-GAMMA and SKETCH execution sequence.

SHORT BURN

This accident presents a situation in which there is a premature engine shutdown. The key information needed for this simulation is the nominal engine burn time and the number of burn durations initiating at the nominal burn location to be considered. The various burn durations, which range within the nominal burn time, are treated with equal probability of occurrence. The input parameters include a nominal burn time of 356.51 seconds with an initial and final engine weight of 33150.362 and 9404.316 pounds, respectively. Engine thrust is 29555.0 pounds. Engine thrust is simulated using 15 pulse burn iterations. The malfunction simulation treats five burn lengths with a conditional occurrence probability of 0.3333. The burns are initiated at a true anomaly of 8.32321° in an elliptical orbit having a perigee of 83.363 nmi and an apogee of 101.92 nmi with a vehicle

```
VOYAGER SAMPLE V-GAMMA PROBLEM
    3
    1     0
SHORT ON TIME CORRECT ORIENTATION BURN (SECOND CENTAUR BURN)
.3333
  83.363    101.92
-.1442     .02749     .98917
33150.362 9404.3160
  184.509
    5    25      17422.813 356.51
   8.23321    8.23321     1
0.            0.          0.
0.            0.          0.
    2     1
NOMINAL ON TIME RANDOM ORIENTATION BURN (SECOND CENTAUR BURN)
.3333
  83.363    101.92
0.0        0.0        1.0
33150.362 9404.3160
  184.509
    1    25                356.51      29555.
   8.23321    8.23321     1
0.         360.       15.
0.0         90.       45.
SUBSEQUENT ON TIME MISORIENTED PROPULSION MODULE BURN (RANDOM CENTAUR)
.999976
4438.34    2100.67
    1    05                44.7992   14633.229
0.           12.        12.
0.           25.        25.
0.0        0.0        0.0
    3     1
NOMINAL BURN AT ABNORMAL LOCATION (SECOND CENTAUR BURN)
.3333
  83.363    101.92
-.1442     .02749     .98917
33150.362 9404.3160
  184.509
    1    25                356.51      29555.
   8.23321  58.23321      5
   0.0        0.0        0.0
   0.0        0.0        0.0
RANDOMLY ORIENTED PROPULSION MODULE BURN (ABNORMAL CENTAUR BURN LOCATION)
.000024
4438.34    2100.67
    1    05      6340.89   44.7992
-45.         45.        15.
0.            0.          0.
0.0        0.0        0.0
0000000000000000000000
```

Figure 3. V-GAMMA Sample Input

heading vector of - 0.1442 I + 0.02749J + 0.98917K. The burn periods are 59.42, 118.83, 178.25, 237.67 and 297.09 s.

With the exception of the burn duration, all other mission parameters are nominal.

RANDOM ORIENTATION BURN WITH MISORIENTED SUBSEQUENT BURN

The vehicle and initial conditions described for the short burn simulation are employed for the first burn of this simulation. However, instead of a premature engine shutdown, a guidance system failure is treated. The random orientation is simulated by specifying pitch and yaw variations of 0° to 360° and 0.0° to + 90°, respectively, about the vehicle's heading vectors to define a hemispherical solid angle. This takes advantage of symmetry of events with respect to plus and minus yaw angles to represent complete spherical variations in orientation. Pitch and yaw increments of 45° specify the angular distances between the vehicle's heading vectors at which the various burns are initiated. A conditional occurrence probability of 0.3333 is divided equally among the equally spaced heading vectors by V-GAMMA. For each of the heading vectors, the vehicle burn is simulated followed by a coast period of 184.509 s. After the coast period, a second burn is initiated.

In setting up a burn simulation in which a second burn follows a burn during which a malfunction was experienced, an assessment should be made as to how the malfunction may effect the second burn. Two scenarios which may be descriptive of the second burn conditions are:

a. A complete guidance system failure resulting in the vehicle's maintaining the inertial heading of the first burn during the coast period and subsequent second burn.

b. The vehicle attempts to assume the nominal heading for the second burn under conditions in which it is unaware of its heading or location due to the first malfunction.

For instructive purposes the second scenario will be treated by assuming two burn orientations both having equal probability of occurrence. The first heading will be the inertial heading of the vehicle at the time of the first burn and the second will represent a specified pitch and yaw rotation from that heading.

The second burn has an associated probability of 0.99997. It will be simulated using five pulse burn iterations. The final stage has a net thrust of 14633.229 pounds and has initial and final weights of 4438.34 and 2100.67 pounds, respectively.

The simulation is set up to treat two burns, one along the inertial heading which the vehicle has at time of first burn and a second at a yaw of 25° and a pitch of 12° relative to that heading. V-GAMMA divides the above probability of occurrence by 2 so that the two conditions of the second burn are considered to have equal probabilities of occurrence of 0.499985.

ABNORMAL BURN LOCATION WITH SUBSEQUENT MISDIRECTED SECOND BURN

This simulation is designed to represent a situation in which the vehicles burn takes place at an abnormal true anomaly. The first burn is followed by a propulsion module burn which has a random pitch orientation. As with the random orientation burn, this simulation is performed by specifying a range over which the burn specifications can vary. With the exception of the location of the first burn and the pitch orientation of the second burn, all mission parameters are normal. The abnormal burn location probability is 0.3333. It is distributed over a range of 45° beginning at the nominal true anomaly of 8.323°. A frequency of five burn locations within this range is treated. After separation of the coast, the propulsion module burn is simulated with a random pitch orientation about the nominal mission heading vector. The heading vector for the second burn is specified in the input as 0.314311 2.08×10^{-5} J and 0.949322 K. This vector was derived from pitch and yaw angles of 18.319 and 0.0012, respectively, using the transformation matrix:

$$\begin{bmatrix} H_1 \\ H_2 \\ H_3 \end{bmatrix} \begin{matrix} = \\ = \\ = \end{matrix} \begin{bmatrix} \sin a \cos b & 0 & 0 \\ 0 & \sin b & 0 \\ 0 & 0 & \cos a \cos b \end{bmatrix} \begin{bmatrix} I \\ J \\ K \end{bmatrix}$$

where a is the pitch angle and b is yaw. The vehicle heading at second burn initiation is varied within the pitch plane about the nominal heading. Seven burns are simulated over a pitch range of + 45°, - 45°, about the nominal heading increments of 15°. The probability that the second burn will occur at an abnormal pitch orientation is 0.00002. The option of specifying velocity change instead of engine thrust is employed for this burn. The nominal velocity change is 6340.89 ft/s.

SKETCH SAMPLE INPUT

The SKETCH sample problems are intended to illustrate the flexibility offered in choosing data from V-GAMMA output tapes to be presented in chart-form and in identifying the types of charts to be generated. The problem analyzes the data output tape of the previously discussed V-GAMMA sample simulations. For instructive purposes, only portions of the data resulting from the various accident cases are extracted from the tape. In addition, the accidents are extracted in a sequence different from the sequence in which the accidents were simulated using V-GAMMA and placed on the tape. Only four burn simulations are considered. Since a data set is required for each reading of a file from the V-GAMMA output tape, four data sets follow the first two input cards. If a single file is to be read more than once, then an appropriate number of sets are required for that file. Figure 4 is a listing of the SKETCH sample input data cards.

Title of the Simulation

The first data card of the SKETCH input data gives an overall title for the accident simulations. The second card gives a value of 9 for the KTO input parameter. This indicates that a starting point in the 11 year solar cycle appropriate for January 1978 should be used for orbital lifetime calculations.

Subsequent Misoriented Propulsion Module Burns following the Random Orientation Centaur Burns

All information giving the results of the subsequent misoriented propulsion module burns which followed the random orientation centaur burn simulations are presented in V-GAMMA maps. The centaur burn simulations which resulted in reentries were not followed by propulsion module burns and, therefore, do not appear in the maps. This first data card for this set gives the title of the data file to be analyzed. A ballistic coefficient of 0.2106 units is used for the propulsion module. It, along with a sequential burn flag of 2 indicating that the data file contains sequential burns and a level number of 2 indicating that the subsequent burns should be extracted appear on the second data card. The third data card gives a file number of 2 for the data set. This SKETCH tells that the second file of the V-GAMMA tape contains the information giving the results of the simulation being considered. In addition, this card gives THETAC PITCHC and YAWC values of 370° indicating that SKETCH should extract all cases of true anomaly, pitch and yaw. The fourth data card gives ITYPE (1),

```
VOYAGER SAMPLE V-GAMMA PROBLEM
    9
SUBSEQUENT ON TIME MISORIENTED PROPULSION MODULE BURN (RANDOM CENTAUR)
.02106          2    2
    2     370.       370.       370.
    1    1    1    1
44./992
14.       38.        1.         0.         90.        2.
NOMINAL ABNORMAL BURN LOCATION (SECOND CENTAUR BURN)
.00395          2    1
    3     370.       370.       370.
    1    1    1    1
363.1397
14.       38.        1.         0.         90.        2.
RANDOMLY ORIENTED PROPULSION MODULE BURN (ABNORMAL CENTAUR BURN LOCATION)
.02106          2    2
    3     370.       370.       370.
    0    0    1    1
44./992
14.       38.        1.         0.         90.        2.
SHORT ON TIME CORRECT ORIENTATION BURN (SECOND CENTAUR BURN)
.00395          1    1
    1     370.       370.       370.
    1    1    1    1
363.1397
14.       38.        1.         0.         90.        2.
000000000000000000000
```

Figure 4. SKETCH Sample Input

ITYPE (2), ITYPE (3), and ITYPE (4) all values of 1. This indicates that frequency and probability V-GAMMA maps should be generated for both free flight and powered reentries. An engine burn time of 44.7992 s is placed on the fifth data card. The final data card for the set identifies the scales to be used for the V-GAMMA maps. Indicated from left to right are minimum and maximum velocities of 14.0 and 38.0 ft/s with a scale increment 1.0 kf/s and minimum and maximum flight path angles of 0.0° and 90.0° with a scale increment of 2.0°.

Abnormal Location of Centaur Burn and Subsequent Propulsion Module Burn

Both the first and second burns of this accident simulation are presented in the V-GAMMA maps. Individual sets of maps are generated. The first set gives the results of the Centaur burn. Simulations and the second set gives those of the subsequent propulsion module burns. A set of SKETCH input data cards, similar to that for the subsequent misoriented propulsion module burn, is required for each of the two burns. The data card following the title card for the abnormal burn location gives a ballistic coefficient for the Centaur vehicle of 0.00395. Also on this card is a sequential burn flag of 2 and a level number of 1 indicating that simulations of the first burn are to be extracted for this data set. With the exception of a file number of 3 and a burn time of 363.1347 s for the Centaur, the remainder of the data set is identical to that of the misoriented propulsion module burn. The data set for the propulsion module burns following the abnormal location burns of the Centaur is identical to the data set for the misoriented propulsion module burn with the exceptions of a file number of 3 and a value of 0 for both ITYPE (1) and ITYPE (2) indicating that frequency and probability maps are not to be generated for powered reentries.

Short on Time Correct Orientation Centaur Burn

Data resulting from this simulation are located on the first file of the V-GAMMA output data tape. The sequential burn flag is set to 1 with a level number of 1 indicating that no subsequent burn simulations are to be extracted from the data file and that orbital lifetimes should be calculated for the results of the first burn. The file number in the SKETCH input data set is appropriately given a value of 1. The remainder of the data set is identical to that for the simulation of the abnormal Centaur burn locations.

APPENDIX A

CROSS REFERENCE OF VARIABLES

FOR THE V-GAMMA COMPUTER CODE

AND THE V-GAMMA METHODOLOGY REPORT (ref. 1)

V-GAMMA TERMINOLOGY

V-GAMMA REPORT*	COMPUTER PROGRAM		
α (Θ)	ALPREF	-	Definitiion of reference trajectory
	ALPHA	-	Interim value during pulse burn calculations
α_H	ALPHAH	-	Calculated in RENTRY 60
β_H *(pp 42)	BETAH	-	Calculated in RENTRY 63
C (pp 24,Eq 20)	C	-	Calculated in VECTOR 21
γ	Gamma	-	Calculated in RENTRY 38
e	EREF	-	Definition of reference trajectory. Calculated in SELECT 33
	E	-	Initial interim value during pulse burn calculations
	EP	-	Interim value in primed coordinate system during pulse burn calculation. Calculated in BURN 81
h	HREF	-	Definition of refernce trajectory calculated in SELECT 39
	H	-	Initial interim value during pulsed burn calculation
	HP	-	Interim value in primed coordinate system during pulse burn. Calculated in BURN 77.
H (Θ)	HVIN(I)	-	Input data ACCIN 40
L	NTIN	-	Input data ACCIN 51
m (pp 32,Eq 47)	EOVERM	-	Calculated in BURN 80
$\dot{m}$	Used to calculate g for depletion burns This is not done in V-GAMMA		
M	T1IN	-	Input parameters ACCIN 51
	THETA	-	Initial vehicle location during V-GAMMA calculations
	T	-	Initial vehicle location during burn iteration

*Reference 1, pages 66-69 and cited pages.

	TIP	- Initial vehicle location after burn phase of burn iteration
	T2P	- Final vehicle location after coast phase of burn iteration
n, N	NIN(I)	- Input parameter ACCIN 47
	N	- Do loop parameter for burn iteration BURN 49
p	PREF	- Definition of reference trajectory Calculate in SELECT 39
	P	- Initial interim value during pulse burn calculations
	PP	- Interim value in primed coordinate system during pulse burn Calculated in BURN 79
p	These angles are determined from the inputted heading vector and are used to establish the e^n e_2^n e_3^n coordinate system V-GAMMA 131 - 151	
e	P1IN, P2IN	- Input parameters ACCIN 53
	PITCH	- Calculated in V-GAMMA 160
Ψ	PSI	- Calculated BURN 116
q	GEOP	- Calculated SELECT 27
q^1	GEOA	- Calculated SELECT 28
r (Θ)	RREF	- Calculate V-GAMMA 132
	R	- Initial interim value during pulse burn calculation
	RIP	- Initial value after burn phase of burn iteration
	R2P	- Final value after coast phase of burn iteration
R_c	RCUV(I)	- Calculated in RENTRY 37-41
Script T	T012	- Calculate V-GAMMA 109
Δt	DTIN	- Input parameter ACCIN 47
Δt_n	DTN	- Calculated in SELECT 54
Δtpc	Same as Δt_n	

Δt_2	DTL	- Calculate in V-GAMMA 112
$\Delta t(\Theta_1 \rightarrow \Theta_2)$	Calculate in subroutine TDRIFT Subroutine TDRIFT $(\Theta_1, \Theta_2, \Delta t)$	
Θ	Same as M pg 26	
Θ_c	THETAC	- Calculated in RENTRY 31
$\Theta_1{}^1, \Theta_2{}^1$	TIP	- Initial vehicle location after burn phase of burn iteration Calculated in BURN 86
	T2P	- Final vehicle location after coast phase of burn iteration Calculated in BURN 99
$\Theta_{1N}{}^1, \Theta_{2N}{}^1$	Same as $\Theta_1{}^1$, $\Theta_2{}^1$ only for a time segmented ΔV calculation	
$\Delta\Theta \{\Theta_1 \quad \Delta t\}$	Calculated in subroutine LDRIFT Subroutine LDRIFT $(\Theta_1, \Delta T, Y)$	
$\vec{V}(\Theta)$	VREF	- Calculated V-GAMMA 133
	VP	- Calculated in BURN 64
	V2P	- Calculated in BURN 106
	VC	- Calculated in RENTRY 33
ΔV	DVIN(I)	- Input parameter ACCIN 47
ΔV_{n_N}	DVN	- Calculate at TEMP 7 in BURN
ΔV	DVSV(I)	- Calculate in BURN 58
W_{pc}	WFRE	- Calculated in RENTRY 73
$W_1 \; W_2$	W_1IN, W_2IN	- Input parameters ACCIN 42
$W_{IN_1} \; W_{2N}$	DWN	- Calculated in SELECT 56
Y	Y1IN, Y2IN	- Input parameters ACCIN 54 Yaw Calculated in V-GAMMA 170

COORDINATE SYSTEMS

$\{\hat{i}, \hat{j}, \hat{k}\}$	RREFUU(1) RREFUU(2) RREFUU(3)	Defined in V-GAMMA 131-140
$\{\hat{e}_1{}^1, \hat{e}_2{}^1, \hat{e}_3{}^1\}$	E1SV E2SV E3SV	Define in V-GAMMA 143-147

$\left\{\overset{n}{e}_1\ \ \overset{n}{e}_2\ \ \overset{n}{e}_3\right\}$	DVVEV(1) DVVEV(2) DVVEV(3)	Defined in V-GAMMA 183-186
$\left\{c_1{}^1,\ j_1{}^1,\ k_1{}^1\right\}$	K1PSV I1PSV J1PSV	Defined in BURN 91-96
$\left\{\overset{n}{c}_2{}^1,\ \overset{n}{j}_2{}^1,\ \overset{n}{k}_2{}^1\right\}$	DVUSUN(1) DVUSUN(2) DVUSUN(3)	Defined in BURN 116-136

CONVERSION FACTORS

V-GAMMA REPORT		COMPLETED PROGRAM
1609.344 m = 1 mi	CF(1)	CONSTS 33
6076.1033 ft = 1 nmi	CF(2)	CONSTS 35
5280 ft = 1 mi	CF(3)	CONSTS 37
3.2808 ft = 1 m	CF(4)	CONSTS 39

CONSTANTS

G	G CONSTS 20
GO	GO CONSTS 28
M	EM CONSTS 22
R	RE CONSTS 24
RADIUS OF ATMOSPHERE	RC CONSTS 26

APPENDIX B

COMPUTER OUTPUT FOR SAMPLE V-GAMMA PROBLEM

```
LGJSM,T200.
ACCOUNT(JOHNSON,20070315-JFQ,DYVS,9791)
ATTACH(OLDPL,VGAMMA,ID=NSCMLGJ,CY=4)
REQUEST(NEWPL,*PF)
UPDATE(P,N,L=0)
FTN(A,I,L=0)
FILE(TAPE1,BT=C,RT=S)
LDSET(FILES=TAPE1)
LGO(PL=77777)
RETURN(NEWPL)
RETURN(OLDPL)
ATTACH(OLDPL,SKETCH,ID=NSCMLGJ,CY=2)
UPDATE(P,L=0)
REWIND(TAPE1)
RETURN(LGO)
FTN(A,I,L=0)
FILE(TAPE1,BT=C,RT=S)
LDSET(FILES=TAPE1)
LGO.
0000000000000000000000
```

Figure B1. System Dayfile for the V-GAMMA and SKETCH Sample Problems

```
VOYAGER SAMPLE V-GAMMA PROBLEM

ACCIDENT NUMBER      1    OF        3

NUMBER OF SUBSEQUENT MALFUNCTIONS      0    IN ACCIDENT NUMBER        1
********************************************************************************************

ACCIDENT TITLE         SHORT ON TIME CORRECT ORIENTATION BURN (SECOND CENTAUR BURN)

PROBABILITY OF ACCIDENT OCCURRENCE  .3332999999999994856

PERIGEE(NAUTICAL MILES)         83.3630000000     APOGEE(NAUTICAL MILES)        101.9200000000

HEADING VECTOR     -.14420 I +     .02749 J +     .98917 K

VEHICLE INITIAL WEIGHT(LB)      33150.3620000000  VEHICILE FINAL WEIGHT(LB)       9404.3160000000

COAST TIME TO SUBSEQUENT BURN(SEC)        184.5090000000

NUMBER OF PULSE BURN ITERATIONS     25  DELTAV      17422.8130000000  DELTAT   356.61000

  VARIABLE BURN DURATIONS =     5

LOCATION OF FIRST BURN           8.2332100000    LOCATION OF LAST BURN           8.2332100000
TOTAL NUMBER OF BURN LOCATIONS        1

PITCH VARIES FROM     0.00000 TO    0.00000IN INCREMENTS OF    0.00000

YAW VARIES FROM     0.00000 TO    0.00000IN INCREMENTS OF    0.00000
```

LEVEL	THETA / THETAC	PITCH / VC	YAW / GAMMA	P / ALPHAH	E / BETAH	H / TRE	T / WFRE	GEOP / EVPROB
1	.823321E+01	0.	0.	.236016E+08	.101324E+00	.576713E+12	.358637E+03	.214302E+08
	0.	0.	0.	0.	0.	0.	0.	.666600E-01
1	.823321E+01	0.	0.	.269544E+08	.257818E+00	.61631[illegible]E+12	.165740E+01	.214295E+08
	0.	0.	0.	0.	0.	0.	0.	.666600E-01
1	.823321E+01	0.	0.	.311139E+08	.451751E+00	.662165E+12	.508309E+01	.214320E+08
	0.	0.	0.	0.	0.	0.	0.	.666600E-01
1	.823321E+01	0.	0.	.364096E+08	.698621E+00	.716303E+12	.891053E+01	.214348E+08
	0.	0.	0.	0.	0.	0.	0.	.666600E-01
1	.823321E+01	0.	0.	.434132E+08	.102548E+01	.782167E+12	.131674E+02	.214335E+08
	0.	0.	0.	0.	0.	0.	0.	.666600E-01

```
VOYAGER SAMPLE V-GAMMA PROBLEM

ACCIDENT NUMBER        2    OF        3
NUMBER OF SUBSEQUENT MALFUNCTIONS       1     IN ACCIDENT NUMBER        2
***************************************************************************************************** **

ACCIDENT TITLE          NOMINAL ON TIME RANDOM ORIENTATION BURN (SECOND CENTAUR BURN)

PROBABILITY OF ACCIDENT OCCURRENCE  .33329999999999994456

PERIGEE(NAUTICAL MILES)          83.3630000000     APOGEE(NAUTICAL MILES)        101.9200000000

HEADING VECTOR     0.00000 I +    0.00000 J +    1.00000 K

VEHICLE INITIAL WEIGHT(LB)       33150.3620000000  VEHICILE FINAL WEIGHT(LB)       9404.3160000000


COAST TIME TO SUBSEQUENT BURN(SEC)         184.5090000000

NUMBER OF PULSE BURN ITTERATIONS      25  THRUST      29555.0000000000  DELTA-T   356.51000

LOCATION OF FIRST BURN            8.2332100000    LOCATION OF LAST BURN           8.2332100000
TOTAL NUMBER OF BURN LOCATION          1

PITCH VARIES FROM     0.00000 TO  360.00000IN INCREMENTS OF    15.00000

YAW VARIES FROM     0.00000 TO   90.00000IN INCREMENTS OF    45.00000
***************************************************************************************************** **

                                   DATA FOR SUBSEQUENT MALFUNCTION
                                   *******************************

ACCIDENT TITLE          SUBSEQUENT ON TIME MISORIENTED PROPULSION MODULE BURN (RANDOM CENTAUR)

PROBABILITY OF ACCIDENT OCCURRENCE  .99997600000000001980

VEHICLE INITIAL WEIGHT(LB)       4436.3400000000  VEHICILE FINAL WEIGHT(LB)       2100.6700000000

NUMBER OF PULSE BURN ITTERATIONS      5  THRUST      14633.2290000000  DELTA-T    44.79920

PITCH VARIES FROM     0.00000 TO   12.00000IN INCREMENTS OF   12.00000
```

HEARING VECTOR FOR SEQUENTIAL MALFUNCTION=   0.00000 I +   0.00000 J +   0.00000 K

	THETAC	VC	GAMMA	ALPHAH	BETAH	TRE	WFRE	GEOP EVPROB
1	.823321E+01	0.	0.	.566083E+08	.166137E+01	.893159E+12	.251930E+02	.212704E+08
	0.	0.	0.	0.	0.	0.	0.	.680204E-02
2	.418349E+02	0.	0.	.666904E+08	.217279E+01	.969439E+12	.446258E+02	.210195E+08
	0.	0.	0.	0.	0.	0.	0.	.170047E-02
2	.418349E+02	0.	.250000E+02	.658802E+08	.212894E+01	.963532E+12	.445866E+02	.210551E+08
	0.	0.	0.	0.	0.	0.	0.	.170047E-02
2	.418349E+02	.120000E+02	0.	.640229E+08	.210231E+01	.949853E+12	.466416E+02	.206372E+08
	0.	0.	0.	0.	0.	0.	0.	.170047E-02
2	.418349E+02	.120000E+02	.250000E+02	.634779E+08	.206558E+01	.945802E+12	.464406E+02	.207067E+08
	0.	0.	0.	0.	0.	0.	0.	.170047E-02
1	.823321E+01	0.	.450000E+02	.493184E+08	.131236E+01	.833668E+12	.228342E+02	.213282E+08
	0.	0.	0.	0.	0.	0.	0.	.680204E-02
2	.391083E+02	0.	0.	.588846E+08	.178377E+01	.910939E+12	.412883E+02	.211528E+08
	0.	0.	0.	0.	0.	0.	0.	.170047E-02
2	.391083E+02	0.	.250000E+02	.546441E+08	.161361E+01	.877527E+12	.433930E+02	.209075E+08
	0.	0.	0.	0.	0.	0.	0.	.170047E-02
2	.391083E+02	.120000E+02	0.	.569797E+08	.174294E+01	.896084E+12	.455578E+02	.207732E+08
	0.	0.	0.	0.	0.	0.	0.	.170047E-02
2	.391083E+02	.120000E+02	.250000E+02	.529386E+08	.157861E+01	.863724E+12	.456539E+02	.205299E+08
	0.	0.	0.	0.	0.	0.	0.	.170047E-02
1	.823321E+01	0.	.900000E+02	.308812E+08	.440558E+00	.659683E+12	.124177E+02	.214369E+08
	0.	0.	0.	0.	0.	0.	0.	.680204E-02
2	.270271E+02	0.	0.	.380714E+08	.776625E+00	.732467E+12	.259836E+02	.214290E+08
	0.	0.	0.	0.	0.	0.	0.	.170047E-02
2	.270271E+02	0.	.250000E+02	.330086E+08	.559593E+00	.682028E+12	.323571E+02	.211649E+08
	.348205E+03	.320676E+05	.422680E+01	.181855E+03	.677097E+02	.171566E+05	0.	.170047E-02
2	.270271E+02	.120000E+02	0.	.373645E+08	.773376E+00	.725636E+12	.307760E+02	.210697E+08
	.346907E+03	.342052E+05	.588038E+01	.130825E+01	.429843E+02	.470048E+05	0.	.170047E-02
2	.270271E+02	.120000E+02	.250000E+02	.323900E+08	.562555E+00	.675607E+12	.379760E+02	.207289E+08
	.337246E+03	.320028E+05	.815296E+01	.722815E+01	.618882E+02	.166076E+05	0.	.170047E-02
1	.823321E+01	.150000E+02	0.	.517185E+08	.149376E+01	.853712E+12	.341751E+02	.207391E+08
	0.	0.	0.	0.	0.	0.	0.	.680204E-02
2	.491760E+02	0.	0.	.585459E+08	.189573E+01	.908316E+12	.522963E+02	.202180E+08
	0.	0.	0.	0.	0.	0.	0.	.170047E-02
2	.491760E+02	0.	.250000E+02	.580461E+08	.186203E+01	.904430E+12	.521857E+02	.202815E+08
	0.	0.	0.	0.	0.	0.	0.	.170047E-02
2	.491760E+02	.120000E+02	0.	.558284E+08	.182239E+01	.886985E+12	.544889E+02	.197806E+08
	0.	0.	0.	0.	0.	0.	0.	.170047E-02
2	.491760E+02	.120000E+02	.250000E+02	.555940E+08	.179596E+01	.885121E+12	.541982E+02	.198837E+08
	0.	0.	0.	0.	0.	0.	0.	.170047E-02

2	.455687E+02	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	0.	0.	0.	0.	0.	0.	0.	.170047E-02
2	.455687E+02	0.	.250000E+02	.491681E+08	.142803E+01	.832397E+12	.508383E+02	.202502E+08
	0.	0.	0.	0.	0.	0.	0.	.170047E-02
2	.455687E+02	.120000E+02	0.	.516674E+08	.155584E+01	.853291E+12	.501632E+02	.202154E+08
	0.	0.	0.	0.	0.	0.	0.	.170047E-02
2	.455687E+02	.120000E+02	.250000E+02	.475351E+08	.139721E+01	.818457E+12	.511600E+02	.198294E+08
	0.	0.	0.	0.	0.	0.	0.	.170047E-02
1	.323321E+01	.300000E+02	0.	.450040E+08	.127112E+01	.796369E+12	.441636E+02	.198158E+08
	0.	0.	0.	0.	0.	0.	0.	.680204E-02
2	.575806E+02	0.	0.	.487524E+08	.157297E+01	.828871E+12	.611668E+02	.189479E+08
	0.	0.	0.	0.	0.	0.	0.	.170047E-02
2	.575806E+02	0.	.250000E+02	.485453E+08	.154854E+01	.827108E+12	.609611E+02	.190482E+08
	0.	0.	0.	0.	0.	0.	0.	.170047E-02
2	.575806E+02	.120000E+02	0.	.461673E+08	.150308E+01	.806595E+12	.657361E+02	.184442E+08
	0.	0.	0.	0.	0.	0.	0.	.170047E-02
2	.575806E+02	.120000E+02	.250000E+02	.462076E+08	.148944E+01	.806948E+12	.653135E+02	.185913E+08
	0.	0.	0.	0.	0.	0.	0.	.170047E-02
1	.823321E+01	.300000E+02	.450000E+02	.417968E+08	.104834E+01	.767468E+12	.387582E+02	.204052E+08
	0.	0.	0.	0.	0.	0.	0.	.680204E-02
2	.526274E+02	0.	0.	.469269E+08	.136515E+01	.813204E+12	.550250E+02	.198410E+08
	0.	0.	0.	0.	0.	0.	0.	.170047E-02
2	.526274E+02	0.	.250000E+02	.424686E+08	.120761E+01	.773611E+12	.594522E+02	.192373E+08
	0.	0.	0.	0.	0.	0.	0.	.170047E-02
2	.526274E+02	.120000E+02	0.	.453827E+08	.133912E+01	.799713E+12	.573183E+02	.194016E+08
	0.	0.	0.	0.	0.	0.	0.	.170047E-02
2	.526274E+02	.120000E+02	.250000E+02	.410864E+08	.118703E+01	.760918E+12	.618179E+02	.187864E+08
	0.	0.	0.	0.	0.	0.	0.	.170047E-02
1	.823321E+01	.450000E+02	0.	.373024E+08	.102485E+01	.725032E+12	.564173E+02	.184223E+08
	0.	0.	0.	0.	0.	0.	0.	.680204E-02
2	.683407E+02	0.	0.	.383635E+08	.124240E+01	.735272E+12	.726603E+02	.171082E+08
	0.	0.	0.	0.	0.	0.	0.	.170047E-02
2	.683407E+02	0.	.250000E+02	.384103E+08	.122561E+01	.735720E+12	.723115E+02	.172584E+08
	0.	0.	0.	0.	0.	0.	0.	.170047E-02
2	.683407E+02	.120000E+02	0.	.360533E+08	.118294E+01	.712789E+12	.759195E+02	.165159E+08
	0.	0.	0.	0.	0.	0.	0.	.170047E-02
2	.683407E+02	.120000E+02	.250000E+02	.363158E+08	.117172E+01	.715380E+12	.752875E+02	.167221E+08
	0.	0.	0.	0.	0.	0.	0.	.170047E-02
1	.823321E+01	.450000E+02	.450000E+02	.366404E+08	.872483E+00	.718569E+12	.483807E+02	.195678E+08
	0.	0.	0.	0.	0.	0.	0.	.680204E-02
2	.611192E+02	0.	0.	.398320E+08	.112268E+01	.749212E+12	.654740E+02	.187649E+08
	0.	0.	0.	0.	0.	0.	0.	.170047E-02

2	.611192E+02	.120000E+02	0.	.387220E+08	.111242E+01	.738700E+12	.656978E+02	.183307E+08
	0.	0.	0.	0.	0.	0.	0.	.170047E-02
2	.611192E+02	.120000E+02	.250000E+02	.343135E+08	.975158E+00	.695378E+12	.725313E+02	.173725E+08
	.308644E+03	.360751E+05	.253316E+02	.290460E+01	.335685E+02	.977692E+06	0.	.170047E-02
1	.823321E+01	.600000E+02	0.	.294163E+08	.794622E+00	.643847E+12	.732671E+02	.163914E+08
	0.	0.	0.	0.	0.	0.	0.	.680204E-02
2	.837739E+02	0.	0.	.283111E+08	.951505E+00	.631636E+12	.892336E+02	.145073E+08
	.290133E+03	.356996E+05	.339390E+02	.209060E+03	0.	.272513E+06	0.	.170047E-02
2	.837739E+02	0.	.250000E+02	.285604E+08	.939640E+00	.634411E+12	.886573E+02	.147246E+08
	.291161E+03	.355500E+05	.331980E+02	.210481E+03	-.254729E+02	.200314E+06	0.	.170047E-02
2	.837739E+02	.120000E+02	0.	.303632E+08	.990941E+00	.654128E+12	.850248E+02	.152507E+08
	.295316E+03	.362381E+05	.321770E+02	.213115E+03	0.	.365497E+07	0.	.170047E-02
2	.837739E+02	.120000E+02	.250000E+02	.304208E+08	.975241E+00	.654748E+12	.848001E+02	.154011E+08
	.295929E+03	.360404E+05	.315860E+02	.215032E+03	-.244154E+02	.819832E+06	0.	.170047E-02
1	.823321E+01	.600000E+02	.450000E+02	.312285E+08	.694898E+00	.663383E+12	.606471E+02	.184250E+08
	0.	0.	0.	0.	0.	0.	0.	.680204E-02
2	.723380E+02	0.	0.	.328159E+08	.889176E+00	.680034E+12	.744856E+02	.173705E+08
	.307293E+03	.350950E+05	.246889E+02	.205675E+03	.345773E+02	.102651E+06	0.	.170047E-02
2	.723380E+02	0.	.250000E+02	.284232E+08	.780799E+00	.632885E+12	.846696E+02	.159609E+08
	.295226E+03	.335862E+05	.279226E+02	.195406E+03	.415207E+02	.315038E+05	0.	.170047E-02
2	.723380E+02	.120000E+02	0.	.321999E+08	.896202E+00	.673621E+12	.761795E+02	.169812E+08
	.304674E+03	.351487E+05	.260194E+02	.202623E+03	.238016E+02	.109526E+06	0.	.170047E-02
2	.723380E+02	.120000E+02	.250000E+02	.278812E+08	.789872E+00	.626823E+12	.862487E+02	.155772E+08
	.292900E+03	.336374E+05	.290985E+02	.195242E+03	.301137E+02	.323927E+05	0.	.170047E-02
1	.823321E+01	.750000E+02	0.	.220313E+08	.632441E+00	.557197E+12	.971736E+02	.134959E+08
	0.	0.	0.	0.	0.	0.	0.	.680204E-02
2	.106355E+03	0.	0.	.193760E+08	.762962E+00	.522542E+12	.112952E+03	.109906E+08
	.263115E+03	.319004E+05	.398182E+02	.242538E+03	0.	.151334E+05	0.	.170047E-02
2	.106355E+03	0.	.250000E+02	.197674E+08	.751878E+00	.527793E+12	.112119E+03	.112836E+08
	.264420E+03	.318070E+05	.389151E+02	.244044E+03	-.268554E+02	.146400E+05	0.	.170047E-02
2	.106355E+03	.120000E+02	0.	.210584E+08	.777464E+00	.544756E+12	.107721E+03	.118474E+08
	.269074E+03	.325095E+05	.382118E+02	.244649E+03	0.	.190098E+05	0.	.170047E-02
2	.106355E+03	.120000E+02	.250000E+02	.212987E+08	.765111E+00	.547855E+12	.107312E+03	.120665E+08
	.269903E+03	.323612E+05	.374559E+02	.246848E+03	-.255311E+02	.179232E+05	0.	.170047E-02
1	.823321E+01	.750000E+02	.450000E+02	.260112E+08	.540788E+00	.605437E+12	.774695E+02	.168817E+08
	0.	0.	0.	0.	0.	0.	0.	.680204E-02
2	.882208E+02	0.	0.	.264136E+08	.691962E+00	.610102E+12	.894153E+02	.156112E+08
	.290165E+03	.323033E+05	.276746E+02	.229175E+03	.394045E+02	.176102E+05	0.	.170047E-02
2	.882208E+02	0.	.250000E+02	.223714E+08	.636770E+00	.561481E+12	.103324E+03	.136680E+08
	.274413E+03	.307744E+05	.311835E+02	.223256E+03	.405949E+02	.105697E+05	0.	.170047E-02
2	.882208E+02	.120000E+02	0.	.261704E+08	.710748E+00	.607287E+12	.902168E+02	.152976E+08
	.288637E+03	.324824E+05	.287589E+02	.226372E+03	.278284E+02	.188799E+05	0.	.170047E-02

1	.823321E+01	.900000E+02	0.	.156597E+08	.585265E+00	.469765E+12	.175611E+03	.987831E+07
	0.	0.	0.	0.	0.	0.	0.	.680204E-02
2	.133962E+03	0.	0.	.120922E+08	.721055E+00	.412801E+12	.139757E+03	.702602E+07
	.233094E+03	.276059E+05	.454794E+02	.282417E+03	0.	.503282E+04	0.	.170047E-02
2	.133962E+03	0.	.250000E+02	.125636E+08	.707107E+00	.420772E+12	.138883E+03	.735961E+07
	.234473E+03	.275815E+05	.443291E+02	.284678E+03	-.289618E+02	.498116E+04	0.	.170047E-02
2	.133962E+03	.120000E+02	0.	.133632E+08	.710653E+00	.433954E+12	.135090E+03	.781175E+07
	.238303E+03	.282771E+05	.439786E+02	.285731E+03	0.	.575962E+04	0.	.170047E-02
2	.133562E+03	.120000E+02	.250000E+02	.137275E+08	.697713E+00	.439830E+12	.134563E+03	.808589E+07
	.239290E+03	.281911E+05	.429820E+02	.288619E+03	-.272506E+02	.563160E+04	0.	.170047E-02
1	.823321E+01	.900000E+02	.450000E+02	.213474E+08	.438414E+00	.548481E+12	.100272E+03	.148409E+08
	0.	0.	0.	0.	0.	0.	0.	.680204E-02
2	.110217E+03	0.	0.	.210072E+08	.556432E+00	.544092E+12	.109183E+03	.134970E+08
	.268458E+03	.292991E+05	.294527E+02	.265531E+03	.455299E+02	.710774E+04	0.	.170047E-02
2	.110217E+03	0.	.250000E+02	.173738E+08	.565552E+00	.494807E+12	.124944E+03	.110976E+08
	.250870E+03	.277468E+05	.332601E+02	.260249E+03	.425461E+02	.497528E+04	0.	.170047E-02
2	.110217E+03	.120000E+02	0.	.209525E+08	.578855E+00	.543384E+12	.108684E+03	.132707E+08
	.268264E+03	.295695E+05	.304945E+02	.261167E+03	.336483E+02	.762341E+04	0.	.170047E-02
2	.110217E+03	.120000E+02	.250000E+02	.173437E+08	.582079E+00	.494379E+12	.123996E+03	.109626E+08
	.251287E+03	.280061E+05	.341336E+02	.260551E+03	.308353E+02	.529104E+04	0.	.170047E-02
1	.823321E+01	.105000E+03	0.	.105847E+08	.638307E+00	.386213E+12	.149263E+03	.646073E+07
	0.	0.	0.	0.	0.	0.	0.	.680204E-02
2	.156092E+03	0.	0.	.670081E+07	.786747E+00	.307293E+12	.160435E+03	.375029E+07
	.209345E+03	.228089E+05	.508222E+02	.310442E+03	0.	.228689E+04	0.	.170047E-02
2	.156092E+03	0.	.250000E+02	.719519E+07	.769690E+00	.318427E+12	.159760E+03	.406579E+07
	.210584E+03	.228759E+05	.492544E+02	.314360E+03	-.324375E+02	.227471E+04	0.	.170047E-02
2	.156092E+03	.120000E+02	0.	.756534E+07	.766524E+00	.326515E+12	.157489E+03	.428261E+07
	.212669E+03	.235224E+05	.493917E+02	.317293E+03	0.	.252876E+04	0.	.170047E-02
2	.156092E+03	.120000E+02	.250000E+02	.799473E+07	.751089E+00	.335653E+12	.157011E+03	.456558E+07
	.213665E+03	.235218E+05	.480011E+02	.321714E+03	-.301156E+02	.249497E+04	0.	.170047E-02
1	.823321E+01	.105000E+03	.450000E+02	.174743E+08	.404793E+00	.496236E+12	.126019E+03	.124390E+08
	0.	0.	0.	0.	0.	0.	0.	.680204E-02
2	.135327E+03	0.	0.	.168209E+08	.492326E+00	.486870E+12	.191494E+03	.112716E+08
	.244988E+03	.262079E+05	.294146E+02	.312113E+03	.529215E+02	.351132E+04	0.	.170047E-02
2	.135327E+03	0.	.250000E+02	.135166E+08	.558333E+00	.436438E+12	.145181E+03	.867375E+07
	.229813E+03	.245763E+05	.336232E+02	.297465E+03	.478768E+02	.262601E+04	0.	.170047E-02
2	.135327E+03	.120000E+02	0.	.168072E+08	.512259E+00	.486672E+12	.129701E+03	.111140E+08
	.245964E+03	.265165E+05	.306160E+02	.304677E+03	.410127E+02	.379166E+04	0.	.170047E-02
2	.135327E+03	.120000E+02	.250000E+02	.135252E+08	.570514E+00	.436577E+12	.143460E+03	.861195E+07
	.230120E+03	.248753E+05	.346186E+02	.297914E+03	.363926E+02	.281874E+04	0.	.170047E-02
1	.823321E+01	.120000E+03	0.	.687969E+07	.727674E+00	.311367E+12	.164472E+03	.398205E+07
	0.	0.	0.	0.	0.	0.	0.	.680204E-02

2	.170323E+03	0.	.250000E+02	.363944E+07	.860067E+00	.226469E+12	.172256E+03	.195664E+07
	.195361E+03	.177128E+05	.531645E+02	.329073E+03	-.386752E+02	.113668E+04	0.	.170047E-02
2	.170323E+03	.120000E+02	0.	.367469E+07	.861342E+00	.227562E+12	.171090E+03	.197421E+07
	.196068E+03	.182156E+05	.541417E+02	.332373E+03	0.	.125234E+04	0.	.170047E-02
2	.170323E+03	.120000E+02	.250000E+02	.411702E+07	.843932E+00	.240869E+12	.170748E+03	.223274E+07
	.197024E+03	.183448E+05	.519992E+02	.339566E+03	-.352940E+02	.123688E+04	0.	.170047E-02
1	.823321E+01	.120000E+03	.450000E+02	.144990E+08	.423156E+00	.452020E+12	.148021E+03	.101879E+08
	0.	0.	0.	0.	0.	0.	0.	.680204E-02
2	.156899E+03	0.	0.	.139092E+08	.477870E+00	.442731E+12	.151749E+03	.941164E+07
	.223297E+03	.232331E+05	.266784E+02	.176786E+03	.609955E+02	.182607E+04	0.	.170047E-02
2	.156899E+03	0.	.250000E+02	.108006E+08	.582035E+00	.390133E+12	.160968E+03	.682703E+07
	.212807E+03	.214200E+05	.313468E+02	.329330E+03	.563568E+02	.142773E+04	0.	.170047E-02
2	.156899E+03	.120000E+02	0.	.138609E+08	.493712E+00	.441962E+12	.149066E+03	.927951E+07
	.224844E+03	.235096E+05	.281766E+02	.351120E+03	.494152E+02	.200741E+04	0.	.170047E-02
2	.156899E+03	.120000E+02	.250000E+02	.107785E+08	.590854E+00	.389734E+12	.158974E+03	.677530E+07
	.213167E+03	.216927E+05	.326018E+02	.330970E+03	.451273E+02	.155527E+04	0.	.170047E-02
1	.823321E+01	.135000E+03	0.	.443007E+07	.807942E+00	.249858E+12	.173594E+03	.245034E+07
	0.	0.	0.	0.	0.	0.	0.	.680204E-02
2	.178666E+03	0.	0.	.120081E+07	.948223E+00	.130085E+12	.178891E+03	.616361E+06
	.185603E+03	.117378E+05	.586904E+02	.323012E+03	0.	.507062E+03	0.	.170047E-02
2	.178666E+03	0.	.250000E+02	.162483E+07	.929891E+00	.151319E+12	.178800E+03	.841928E+06
	.186555E+03	.121692E+05	.543340E+02	.334515E+03	-.509106E+02	.503336E+03	0.	.170047E-02
2	.178666E+03	.120000E+02	0.	.143569E+07	.938450E+00	.142239E+12	.178132E+03	.740641E+06
	.186357E+03	.122659E+05	.570604E+02	.336709E+03	0.	.568736E+03	0.	.170047E-02
2	.178666E+03	.120000E+02	.250000E+02	.185400E+07	.920394E+00	.161638E+12	.178029E+03	.965429E+06
	.187235E+03	.126322E+05	.531306E+02	.349814E+03	-.455011E+02	.559433E+03	0.	.170047E-02

LEVEL	THETA / THETAC	PITCH / VC	YAW / GAMMA	P / ALPHAH	E / BETAH	H / THE	T / WFRE	GEOP / EVPROB
1	.823321E+01	.135000E+03	.450000E+02	.124324E+08	.458218E+00	.418564E+12	.164056E+03	.852573E+07
	0.	0.	0.	0.	0.	0.	0.	.680204E-02
2	.172764E+03	0.	0.	.122004E+08	.477184E+00	.414645E+12	.168461E+03	.825925E+07
	.206265E+03	.207250E+05	.202599E+02	.118564E+03	.679539E+02	.873017E+03	0.	.170047E-02
2	.172764E+03	0.	.250000E+02	.919909E+07	.605267E+00	.359069E+12	.172881E+03	.869942E+07
	.199373E+03	.185894E+05	.250796E+02	.357933E+03	.671864E+02	.707841E+03	0.	.170047E-02
2	.172764E+03	.120000E+02	0.	.121045E+08	.488942E+00	.413012E+12	.165019E+03	.812961E+07
	.207823E+03	.208730E+05	.219037E+02	.139112E+03	.576729E+02	.100745E+04	0.	.170047E-02
2	.172764E+03	.120000E+02	.250000E+02	.908283E+07	.612018E+00	.357766E+12	.170658E+03	.863445E+07
	.200273E+03	.187402E+05	.264695E+02	.177621E+03	.562751E+02	.800569E+03	0.	.170047E-02
1	.823321E+01	.150000E+03	0.	.301435E+07	.862133E+00	.206104E+12	.179207E+03	.161876E+07
	0.	0.	0.	0.	0.	0.	0.	.680204E-02
2	.183800E+03	0.	0.	.342476E+06	.984224E+00	.694711E+11	.181263E+03	.172600E+06
	.181373E+03	.578695E+04	.557430E+02	.300151E+03	0.	.573387E+02	0.	.170047E-02
2	.183800E+03	0.	.250000E+02	.720381E+06	.966836E+00	.100756E+12	.181891E+03	.366264E+06
	.182043E+03	.675032E+04	.455822E+02	.327747E+03	-.747475E+02	.568633E+02	0.	.170047E-02
2	.183800E+03	.120000E+02	0.	.410118E+06	.980992E+00	.760227E+11	.180975E+03	.207027E+06
	.181219E+03	.526082E+04	.473438E+02	.325697E+03	0.	.703796E+02	0.	.170047E-02
2	.183800E+03	.120000E+02	.250000E+02	.791721E+06	.963336E+00	.105627E+12	.181461E+03	.403253E+06
	.181770E+03	.634731E+04	.387110E+02	.174000E+03	-.669800E+02	.681266E+02	0.	.170047E-02
1	.823321E+01	.150000E+03	.450000E+02	.112173E+08	.485991E+00	.397587E+12	.176116E+03	.754869E+07
	0.	0.	0.	0.	0.	0.	0.	.680204E-02
2	.184957E+03	0.	0.	.115402E+08	.469007E+00	.403270E+12	.183856E+03	.785580E+07
	.191930E+03	.192105E+05	.101577E+02	.476549E+02	.705553E+02	.206907E+03	0.	.170047E-02
2	.184957E+03	0.	.250000E+02	.841757E+07	.612716E+00	.344415E+12	.183077E+03	.621950E+07
	.188924E+03	.166114E+05	.135399E+02	.152749E+03	.790318E+02	.182216E+03	0.	.170047E-02
2	.184957E+03	.120000E+02	0.	.114253E+08	.474002E+00	.401258E+12	.179463E+03	.775124E+07
	.191634E+03	.191122E+05	.101162E+02	.770959E+02	.637207E+02	.291668E+03	0.	.170047E-02
2	.184957E+03	.120000E+02	.250000E+02	.833104E+07	.616328E+00	.342640E+12	.180468E+03	.515430E+07
	.188626E+03	.165102E+05	.133137E+02	.138521E+03	.685119E+02	.238273E+03	0.	.170047E-02
1	.823321E+01	.165000E+03	0.	.486429E+07	.773210E+00	.261817E+12	.185045E+03	.374321E+07
	.183320E+03	.175110E+05	.111072E+02	.347499E+03	0.	.307828E+03	.324255E+04	.680204E-02
1	.823321E+01	.165000E+03	.450000E+02	.109366E+08	.489928E+00	.392582E+12	.185367E+03	.734037E+07
	.186071E+03	.185019E+05	.576917E+01	.355029E+03	.823855E+02	.342235E+03	.950836E+03	.680204E-02
1	.823321E+01	.180000E+03	0.	.122224E+08	.430274E+00	.415018E+12	.186792E+03	.864548E+07
	.187190E+03	.195460E+05	.536807E+01	.343772E+03	0.	.178750E+03	.118400E+05	.680204E-02
1	.823321E+01	.180000E+03	.450000E+02	.144018E+08	.328880E+00	.450503E+12	.188960E+03	.108376E+08
	.189148E+03	.211874E+05	.442765E+01	.339679E+03	.597399E+02	.202962E+03	.102274E+05	.680204E-02
1	.823321E+01	.195000E+03	0.	.155360E+08	.278673E+00	.467906E+12	.192237E+03	.121501E+08
	.193015E+03	.220215E+05	.492403E+01	.331985E+03	0.	.127310E+03	.152663E+05	.680204E-02

1	.823321E+01	.210000E+03	0.	.168184E+08	.225737E+00	.486834E+12	.200344E+03	.137210E+08
	.200542E+03	.229426E+05	.573560E+01	.317552E+03	0.	.103049E+03	.168822E+05	.680204E-02
1	.823321E+01	.210000E+03	.450000E+02	.179567E+08	.172083E+00	.503039E+12	.202860E+03	.153203E+08
	.203335E+03	.236648E+05	.462820E+01	.312713E+03	.506727E+02	.121580E+03	.156480E+05	.680204E-02
1	.823321E+01	.225000E+03	0.	.182061E+08	.171219E+00	.506521E+12	.211005E+03	.155446E+08
	.211291E+03	.238793E+05	.594707E+01	.303082E+03	0.	.900461E+02	.177484E+05	.680204E-02
1	.823321E+01	.225000E+03	.450000E+02	.190035E+08	.132700E+00	.517494E+12	.214362E+03	.167772E+08
	.214834E+03	.243530E+05	.486204E+01	.297999E+03	.487579E+02	.107070E+03	.166145E+05	.680204E-02
1	.823321E+01	.240000E+03	0.	.195483E+08	.122178E+00	.524860E+12	.226196E+03	.174200E+08
	.226968E+03	.247273E+05	.556485E+01	.288847E+03	0.	.829957E+02	.182180E+05	.680204E-02
1	.823321E+01	.240000E+03	.450000E+02	.200353E+08	.973835E-01	.531358E+12	.230646E+03	.182574E+08
	.231962E+03	.249974E+05	.464192E+01	.283912E+03	.470806E+02	.992705E+02	.171339E+05	.680204E-02
1	.823321E+01	.255000E+03	0.	.205704E+08	.103899E+00	.538406E+12	.249495E+03	.186343E+08
	.250849E+03	.253750E+05	.578169E+01	.273790E+03	0.	.794740E+02	.184525E+05	.680204E-02
1	.823321E+01	.255000E+03	.450000E+02	.209013E+08	.848104E-01	.542719E+12	.255736E+03	.192672E+08
	.256404E+03	.255380E+05	.480787E+01	.268752E+03	.458059E+02	.953425E+02	.173956E+05	.680204E-02
1	.823321E+01	.270000E+03	0.	.216826E+08	.101270E+00	.552770E+12	.278951E+03	.196887E+08
	.279492E+03	.260442E+05	.561088E+01	.258911E+03	0.	.790757E+02	.184791E+05	.680204E-02
1	.823321E+01	.270000E+03	.450000E+02	.218368E+08	.866572E-01	.554732E+12	.289363E+03	.200954E+08
	.286030E+03	.260974E+05	.465026E+01	.254020E+03	.445440E+02	.951277E+02	.174099E+05	.680204E-02
1	.823321E+01	.285000E+03	0.	.228100E+08	.117921E+00	.566959E+12	.308547E+03	.204113E+08
	.306295E+03	.266888E+05	.506084E+01	.244196E+03	0.	.817973E+02	.182978E+05	.680204E-02
1	.823321E+01	.285000E+03	.450000E+02	.227794E+08	.103433E+00	.566578E+12	.310263E+03	.206441E+08
	.311200E+03	.266374E+05	.416723E+01	.239625E+03	.433765E+02	.987132E+02	.171711E+05	.680204E-02
1	.823321E+01	.300000E+03	0.	.243753E+08	.173528E+00	.586089E+12	.326261E+03	.207710E+08
	.325472E+03	.275834E+05	.491841E+01	.228780E+03	0.	.884270E+02	.178562E+05	.680204E-02
1	.823321E+01	.300000E+03	.450000E+02	.240888E+08	.150891E+00	.582634E+12	.328624E+03	.209305E+08
	.329139E+03	.273839E+05	.392009E+01	.224398E+03	.419024E+02	.106836E+03	.166301E+05	.680204E-02
1	.823321E+01	.315000E+03	0.	.261896E+08	.243772E+00	.607510E+12	.339131E+03	.210566E+08
	.339301E+03	.285563E+05	.401355E+01	.213585E+03	0.	.102037E+03	.169497E+05	.680204E-02
1	.823321E+01	.315000E+03	.450000E+02	.255608E+08	.208408E+00	.600172E+12	.341524E+03	.211524E+08
	.342306E+03	.281814E+05	.302527E+01	.209550E+03	.404171E+02	.124426E+03	.154584E+05	.680204E-02
1	.823321E+01	.330000E+03	0.	.290334E+08	.365540E+00	.639643E+12	.350712E+03	.212615E+08
	.351350E+03	.300174E+05	.231243E+01	.197531E+03	0.	.136264E+03	.146699E+05	.680204E-02
1	.823321E+01	.330000E+03	.450000E+02	.296025E+08	.389830E+00	.645881E+12	.354160E+03	.212993E+08
	.354944E+03	.302963E+05	.152950E+01	.192519E+03	.370468E+02	.175851E+03	.120331E+05	.680204E-02
1	.823321E+01	.345000E+03	0.	.589768E+08	.175143E+01	.911652E+12	.163240E+02	.214349E+08
	0.	0.	0.	0.	0.	0.	0.	.680204E-02
2	.346455E+02	0.	0.	.722563E+08	.237815E+01	.100908E+13	.371752E+02	.213893E+08
	0.	0.	0.	0.	0.	0.	0.	.170047E-02
2	.346455E+02	0.	.250000E+02	.711412E+08	.232373E+01	.100127E+13	.371966E+02	.214040E+08
	0.	0.	0.	0.	0.	0.	0.	.170047E-02

2	.346455E+02 0.	.170000E+02 0.	.250000E+02 0.	.689803E+08 0.	.226857E+01 0.	.985942E+12 0.	.390163E+02 0.	.211041E+08 .170047E-02
1	.823321E+01 0.	.345000E+03 0.	.450000E+02 0.	.507879E+08 0.	.136933E+01 0.	.845997E+12 0.	.152247E+02 0.	.214356E+08 .480204E-02
2	.326976E+02 0.	0. 0.	0. 0.	.625219E+08 0.	.192162E+01 0.	.938653E+12 0.	.347507E+02 0.	.213997E+08 .170047E-02
2	.326976E+02 0.	0. 0.	.250000E+02 0.	.582724E+08 0.	.174333E+01 0.	.906192E+12 0.	.363335E+02 0.	.212415E+08 .170047E-02
2	.326976E+02 0.	.170000E+02 0.	0. 0.	.607273E+08 0.	.188260E+01 0.	.925083E+12 0.	.370409E+02 0.	.210668E+08 .170047E-02
2	.326976E+02 0.	.170000E+02 0.	.250000E+02 0.	.566679E+08 0.	.170970E+01 0.	.893629E+12 0.	.389891E+02 0.	.209130E+08 .170047E-02

```
VOYAGER SAMPLE V-GAMMA PROBLEM

ACCIDENT NUMBER      3     OF        3
NUMBER OF SUBSEQUENT MALFUNCTIONS       1     IN ACCIDENT NUMBER        3
********************************************************************************************************************

ACCIDENT TITLE         NOMINAL BURN AT ABNORMAL LOCATION (SECOND CENTAUR BURN)

PROBABILITY OF ACCIDENT OCCURRENCE  .33329999999999994456

PERIGEE(NAUTICAL MILES)         83.3630000000     APOGEE(NAUTICAL MILES)        101.9200000000

HEADING VECTOR     -.14420 I +      .02749 J +      .98917 K

VEHICLE INITIAL WEIGHT(LB)      33150.3620000000  VEHICILE FINAL WEIGHT(LB)       9404.3160000000

COAST TIME TO SUBSEQUENT BURN(SEC)        184.5090000000

NUMBER OF PULSE BURN ITERATIONS     25  THRUST      29555.0000000000  DELTA-T   356.51000

LOCATION OF FIRST BURN           8.2332100000    LOCATION OF LAST BURN          59.2332100000
TOTAL NUMBER OF BURN LOCATIONS        5

PITCH VARIES FROM     0.00000 TO    0.00000IN INCREMENTS OF     0.00000

YAW VARIES FROM     0.00000 TO    0.00000IN INCREMENTS OF     0.00000
********************************************************************************************************************

                              DATA FOR SUBSEQUENT MALFUNCTION
                              *******************************

ACCIDENT TITLE         RANDOMLY ORIENTED PROPULSION MODULE BURN (ABNORMAL CENTAUR BURN LOCATION)

PROBABILITY OF ACCIDENT OCCURRENCE  .00002400000000000000

VEHICLE INITIAL WEIGHT(LB)       4438.3400000000  VEHICILE FINAL WEIGHT(LB)       2100.6700000000

NUMBER OF PULSE BURN ITERATIONS      5  DELTAV       6340.8900000000  DELTAT    44.79920

PITCH VARIES FROM   -45.00000 TO   45.00000IN INCREMENTS OF    15.00000

YAW VARIES FROM     0.00000 TO    0.00000IN INCREMENTS OF     0.00000
```

	THETAC	VC	GAMMA	ALPHAH	BETAH	TRE	WFRE	EVPROB
1	.823321E+01	0.	0.	.582612E+08	.172163E+01	.906105E+12	.202971E+02	.214068E+08
	0.	0.	0.	0.	0.	0.	0.	.666600E-01
2	.378691E+02	-.450000E+02	0.	.582612E+08	.172163E+01	.906105E+12	.415690E+02	.214068E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06
2	.378691E+02	-.300000E+02	0.	.582612E+08	.172163E+01	.906105E+12	.415690E+02	.214068E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06
2	.378691E+02	-.150000E+02	0.	.582612E+08	.172163E+01	.906105E+12	.415690E+02	.214068E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06
2	.378691E+02	0.	0.	.582612E+08	.172163E+01	.906105E+12	.415690E+02	.214068E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06
2	.378691E+02	.150000E+02	0.	.582612E+08	.172163E+01	.906105E+12	.415690E+02	.214068E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06
2	.378691E+02	.300000E+02	0.	.582612E+08	.172163E+01	.906105E+12	.415690E+02	.214068E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06
2	.378691E+02	.450000E+02	0.	.582612E+08	.172163E+01	.906105E+12	.415690E+02	.214068E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06
1	.194910E+02	0.	0.	.582480E+08	.172043E+01	.906002E+12	.203266E+02	.214113E+08
	0.	0.	0.	0.	0.	0.	0.	.666600E-01
2	.378854E+02	-.450000E+02	0.	.582480E+08	.172043E+01	.906002E+12	.415827E+02	.214113E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06
2	.378854E+02	-.300000E+02	0.	.582480E+08	.172043E+01	.906002E+12	.415827E+02	.214113E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06
2	.378854E+02	-.150000E+02	0.	.582480E+08	.172043E+01	.906002E+12	.415827E+02	.214113E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06
2	.378854E+02	0.	0.	.582480E+08	.172043E+01	.906002E+12	.415827E+02	.214113E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06
2	.378854E+02	.150000E+02	0.	.582480E+08	.172043E+01	.906002E+12	.415827E+02	.214113E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06
2	.378854E+02	.300000E+02	0.	.582480E+08	.172043E+01	.906002E+12	.415827E+02	.214113E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06
2	.378854E+02	.450000E+02	0.	.582480E+08	.172043E+01	.906002E+12	.415827E+02	.214113E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06
1	.307449E+02	0.	0.	.582244E+08	.171853E+01	.905819E+12	.203981E+02	.214176E+08
	0.	0.	0.	0.	0.	0.	0.	.666600E-01
2	.379324E+02	-.450000E+02	0.	.582244E+08	.171853E+01	.905819E+12	.416246E+02	.214176E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06
2	.379324E+02	-.300000E+02	0.	.582244E+08	.171853E+01	.905819E+12	.416246E+02	.214176E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06
2	.379324E+02	-.150000E+02	0.	.582244E+08	.171853E+01	.905819E+12	.416246E+02	.214176E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06

2	.379324E+02	.150000E+02	0.	.582244E+08	.171853E+01	.905819E+12	.416246E+02	.214176E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06
2	.379324E+02	.300000E+02	0.	.582244E+08	.171853E+01	.905819E+12	.416246E+02	.214176E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06
2	.379324E+02	.450000E+02	0.	.582244E+08	.171853E+01	.905819E+12	.416246E+02	.214176E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06
1	.419929E+02	0.	0.	.582067E+08	.171668E+01	.905681E+12	.204087E+02	.214257E+08
	0.	0.	0.	0.	0.	0.	0.	.666600E-01
2	.379280E+02	-.450000E+02	0.	.582067E+08	.171668E+01	.905681E+12	.416177E+02	.214257E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06
2	.379280E+02	-.300000E+02	0.	.582067E+08	.171668E+01	.905681E+12	.416177E+02	.214257E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06
2	.379280E+02	-.150000E+02	0.	.582067E+08	.171668E+01	.905681E+12	.416177E+02	.214257E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06
2	.379280E+02	0.	0.	.582067E+08	.171668E+01	.905681E+12	.416177E+02	.214257E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06
2	.379280E+02	.150000E+02	0.	.582067E+08	.171668E+01	.905681E+12	.416177E+02	.214257E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06
2	.379280E+02	.300000E+02	0.	.582067E+08	.171668E+01	.905681E+12	.416177E+02	.214257E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06
2	.379280E+02	.450000E+02	0.	.582067E+08	.171668E+01	.905681E+12	.416177E+02	.214257E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06
1	.532333E+02	0.	0.	.581870E+08	.171458E+01	.905528E+12	.204117E+02	.214350E+08
	0.	0.	0.	0.	0.	0.	0.	.666600E-01
2	.379154E+02	-.450000E+02	0.	.581870E+08	.171458E+01	.905528E+12	.416027E+02	.214350E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06
2	.379154E+02	-.300000E+02	0.	.581870E+08	.171458E+01	.905528E+12	.416027E+02	.214350E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06
2	.379154E+02	-.150000E+02	0.	.581870E+08	.171458E+01	.905528E+12	.416027E+02	.214350E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06
2	.379154E+02	0.	0.	.581870E+08	.171458E+01	.905528E+12	.416027E+02	.214350E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06
2	.379154E+02	.150000E+02	0.	.581870E+08	.171458E+01	.905528E+12	.416027E+02	.214350E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06
2	.379154E+02	.300000E+02	0.	.581870E+08	.171458E+01	.905528E+12	.416027E+02	.214350E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06
2	.379154E+02	.450000E+02	0.	.581870E+08	.171458E+01	.905528E+12	.416027E+02	.214350E+08
	0.	0.	0.	0.	0.	0.	0.	.228549E-06

TOTAL EXECUTION TIME FOR THIS RUN =   .894 S

FREQUENCY OF OCCURRENCE V-GAMMA MAP
FOR ALL REENTRY EVENTS CONSIDERED.
ENTRIES EXPRESSED IN UNITS OF 1 COUNTS PER BIN.

GAMMA (DEG)	14.00	15.00	16.00	17.00	18.00	19.00	20.00	21.00	22.00	23.00	24.00	25.00	26.00	27.00	28.00	29.00	30.00	31.00	32.00	33.00	34.00	35.00	36.00	37.00	38.00
88.00-90.00																									
86.00-88.00																									
84.00-86.00																									
82.00-84.00																									
80.00-82.00																									
78.00-80.00																									
76.00-78.00																									
74.00-76.00																									
72.00-74.00																									
70.00-72.00																									
68.00-70.00																									
66.00-68.00																									
64.00-66.00																									
62.00-64.00																									
60.00-62.00																									
58.00-60.00																									
56.00-58.00																									
54.00-56.00					1	1																			
52.00-54.00					1																				
50.00-52.00						1				1															
48.00-50.00										1	2														
46.00-48.00																									
44.00-46.00															2										
42.00-44.00																2									
40.00-42.00																									
38.00-40.00																			2	1					
36.00-38.00																				1					
34.00-36.00												1				1									
32.00-34.00									1			1			1			1					2	1	
30.00-32.00									1					1			1	1						1	
28.00-30.00											1			1			1			1	1				
26.00-28.00						1					1									1	1		1		
24.00-26.00						1																	1	1	
22.00-24.00																								1	
20.00-22.00								2																	
18.00-20.00																									
16.00-18.00																									
14.00-16.00																									
12.00-14.00				2																					
10.00-12.00							2																		
8.00-10.00																				1					
6.00- 8.00																									
4.00- 6.00																				1		1			
2.00- 4.00																									
.00- 2.00																									

ENTRY SPEED (KILOFEET PER SECOND)

SUBSEQUENT ON TIME MISORIENTED PROPULSION MODULE BURN (RANDOM CENTAUR)

PROBABILITY OF OCCURRENCE V-GAMMA MAP
FOR ALL REENTRY EVENTS CONSIDERED.

GAMMA (DEG)	14.00	15.00	16.00	17.00	18.00	19.00	20.00	21.00	22.00	23.00	24.00	25.00	26.00	27.00	28.00	29.00	30.00	31.00	32.00	33.00	34.00	35.00	36.00	37.00	38.00
88.00-90.00																									
86.00-88.00																									
84.00-86.00																									
82.00-84.00																									
80.00-82.00																									
78.00-80.00																									
76.00-78.00																									
74.00-76.00																									
72.00-74.00																									
70.00-72.00																									
68.00-70.00																									
66.00-68.00																									
64.00-66.00																									
62.00-64.00																									
60.00-62.00																									
58.00-60.00																									
56.00-58.00																									
54.00-56.00					2 -3	2 -3																			
52.00-54.00					2 -3																				
50.00-52.00						2 -3				2 -3															
48.00-50.00										2 -3	3 -3														
46.00-48.00																									
44.00-46.00															3 -3										
42.00-44.00																3 -3									
40.00-42.00																									
38.00-40.00																			3 -3	2 -3					
36.00-38.00																				2 -3					
34.00-36.00												2 -3				2 -3									
32.00-34.00									2 -3			2 -3			2 -3			2 -3					3 -3	2 -3	
30.00-32.00									2 -3					2 -3			2 -3	2 -3						2 -3	
28.00-30.00											2 -3			2 -3			2 -3			2 -3	2 -3				
26.00-28.00						2 -3					2 -3									2 -3	2 -3		2 -3		
24.00-26.00						2 -3																	2 -3	2 -3	
22.00-24.00																								2 -3	
20.00-22.00								3 -3																	
18.00-20.00																									
16.00-18.00																									
14.00-16.00																									
12.00-14.00				3 -3																					
10.00-12.00							3 -3																		
8.00-10.00																				2 -3					
6.00- 8.00																									
4.00- 6.00																				2 -3		2 -3			
2.00- 4.00																									
.00- 2.00																									

ENTRY SPEED (KILOPEET PER SECOND)

THE FOLLOWING DATA SUMMARIZES THE ENTIRE ACCIDENT FILE
ACCIDENT TITLE---SUBSEQUENT ON TIME MISORIENTED PROPULSION MODULE BURN (RANDOM CENTAUR)

SUMMARY OF RESULTS FROM FILE 2
MAXIUM AND MINIUM VALUES
VMIN = 5.26082(KILOFEET PER SECOND)
VMAX = 36.23805(KILOFEET PER SECOND)
GMIN = 4.22680(DEGREES)
GMAX = 58.69043(DEGREES)

FREQUENCY AND PROBABILISTIC DATA

FINAL TRAJECTORY	RESULT	NUMBER	PROBABILITY
ELLIPTIC	REENTRY	61	.1037286E+00
	POWERED REENTRY	0	0.
	ORBIT	1	.1700469E-02
PARABOLIC	REENTRY	0	0.
	POWERED REENTRY	0	0.
	ESCAPE	0	0.
HYPERBOLIC	REENTRY	0	0.
	POWERED REENTRY	0	0.
	ESCAPE	38	.6461784E-01
ALL	REENTRY	61	.1037286E+00
	POWERED REENTRY	0	0.
	ESCAPE	39	.6631831E-01
TOTAL	TOTAL	100	.1700469E+00

OFF SCALE POINT SUMMARY

TOTAL NUMBER OF OFF SCALE POINTS = 8

TOTAL NUMBER OF OFF SCALE POWERED REENTRY POINTS = 0

MAX GAMMA ANGLE FOR OFF SCALE POINTS	V = 11473780 (KPS)	GAMMA = 58.69043 (DEGREES)
MAX VELOCITY FOR OFF SCALE POINTS	V = 12663220 (KPS)	GAMMA = 59.13056 (DEGREES)
MAX ANGLE FOR POWERED REENTRY OFF SCALE POINTS	V = 0.00000 (KPS)	GAMMA = -.00000 (DEGREES)
MAX VELOCITY FOR POWERED REENTRY OFF SCALE POINTS	V = -.00000 (KPS)	GAMMA = 0.00000 (DEGREES)

NOTE--- OFF SCALE POINTS ARE INCLUDED IN ALL ACCIDENT STATISTICS EXCEPT THE FREQUENCY AND PROBABILISTIC MAPS

FREQUENCY OF REENTRY TIMES

TIME FROM MALFUNCTION TO REENTRY

SECONDS		MINUTES		HOURS	
1	0	1	2	1	8
2	0	2	0	2	2
3	0	3	3	3	1
4	0	4	1	4	6
5	0	5	0	5	2
6	0	6	0	6	0
7	0	7	0	7	0
8	0	8	2	8	2
9	0	9	2	9	0
10	0	10	0	10	0
11	0	11	1	11	0
12	0	12	0	12	0
13	0	13	1	13	1
14	0	14	1	14	0
15	0	15	0	15	0
16	0	16	1	16	0
17	0	17	0	17	0
18	0	18	1	18	0
19	0	19	1	19	0
20	0	20	2	20	0
21	0	21	0	21	0
22	0	22	0	22	0
23	0	23	1	23	0
24	0	24	0	24	0
25	2	25	10	.GT.24	8
26	0	26	0		
27	0	27	0		
28	0	28	0		
29	0	29	0		
30	0	30	0		
31	0	31	0		
32	0	32	0		
33	0	33	0		
34	0	34	0		
35	0	35	0		
36	0	36	0		
37	0	37	0		
38	0	38	0		
39	0	39	0		
40	0	40	0		
41	0	41	0		
42	0	42	0		
43	0	43	0		
44	0	44	0		
45	0	45	0		
46	0	46	0		
47	0	47	0		
48	0	48	0		
49	0	49	0		
50	0	50	0		
51	0	51	0		
52	0	52	0		
53	0	53	0		
54	0	54	0		
55	0	55	0		
56	0	56	0		
57	0	57	0		
58	0	58	0		

BURNTIME LEFT DURING POWERED REENTRY

SECONDS		MINUTES		HOURS	
1	0	1	0	1	0
2	0	2	0	2	0
3	0	3	0	3	0
4	0	4	0	4	0
5	0	5	0	5	0
6	0	6	0	6	0
7	0	7	0	7	0
8	0	8	0	8	0
9	0	9	0	9	0
10	0	10	0	10	0
11	0	11	0	11	0
12	0	12	0	12	0
13	0	13	0	13	0
14	0	14	0	14	0
15	0	15	0	15	0
16	0	16	0	16	0
17	0	17	0	17	0
18	0	18	0	18	0
19	0	19	0	19	0
20	0	20	0	20	0
21	0	21	0	21	0
22	0	22	0	22	0
23	0	23	0	23	0
24	0	24	0	24	0
25	0	25	0	26	0
26	0	26	0		
27	0	27	0		
28	0	28	0		
29	0	29	0		
30	0	30	0		
31	0	31	0		
32	0	32	0		
33	0	33	0		
34	0	34	0		
35	0	35	0		
36	0	36	0		
37	0	37	0		
38	0	38	0		
39	0	39	0		
40	0	40	0		
41	0	41	0		
42	0	42	0		
43	0	43	0		
44	0	44	0		
45	0	45	0		
46	0	46	0		
47	0	47	0		
48	0	48	0		
49	0	49	0		
50	0	50	0		
51	0	51	0		
52	0	52	0		
53	0	53	0		
54	0	54	0		
55	0	55	0		
56	0	56	0		
57	0	57	0		
58	0	58	0		

FREQUENCY OF REENTRY ORIENTATION

1	1	61	0	121	0	181	1	241	0	301	1
2	1	62	0	122	0	182	0	242	1	302	0
3	1	63	0	123	0	183	0	243	0	303	0
4	0	64	0	124	0	184	0	244	2	304	1
5	0	65	0	125	0	185	0	245	0	305	0
6	0	66	0	126	0	186	0	246	1	306	0
7	0	67	0	127	0	187	0	247	0	307	0
8	1	68	0	12A	0	188	0	248	0	308	0
9	0	69	0	129	0	189	0	249	0	309	0
10	0	70	0	130	0	190	0	250	0	310	1
11	0	71	0	131	0	191	0	251	0	311	0
12	0	72	0	132	0	192	0	252	0	312	1
13	0	73	0	133	0	193	0	253	0	313	0
14	0	74	0	134	0	194	0	254	0	314	1
15	0	75	0	135	0	195	2	255	0	315	0
16	0	76	0	136	0	196	0	256	0	316	0
17	0	77	1	137	0	197	0	257	0	317	1
1A	0	78	0	138	1	198	0	258	0	318	0
19	0	79	0	139	1	199	0	259	0	319	0
20	0	80	0	140	0	200	0	260	2	320	0
21	0	81	0	141	0	201	0	261	1	321	1
22	0	82	0	142	0	202	1	262	0	322	1
23	0	83	0	143	0	203	0	263	0	323	1
24	0	84	0	144	0	204	0	264	0	324	0
25	0	85	0	145	0	205	1	265	1	325	1
26	0	86	0	146	0	206	0	266	0	326	0
27	0	87	0	147	0	207	0	267	0	327	1
28	0	88	0	148	0	208	0	268	0	328	0
29	0	89	0	149	0	209	1	269	0	329	2
30	0	90	0	150	0	210	1	270	0	330	1
31	0	91	0	151	0	211	0	271	0	331	0
32	0	92	0	152	1	212	0	272	0	332	1
33	0	93	0	153	0	213	1	273	0	333	0
34	0	94	0	154	0	214	0	274	0	334	1
35	0	95	0	155	0	215	1	275	0	335	0
36	0	96	0	156	0	216	0	276	0	336	1
37	0	97	0	157	0	217	0	277	0	337	0
38	0	98	0	158	0	218	0	278	0	338	0
39	0	99	0	159	0	219	0	279	0	339	1
40	0	100	0	160	0	220	0	280	0	340	0
41	0	101	0	161	0	221	0	281	0	341	0
42	0	102	0	162	0	222	0	282	1	342	0
43	0	103	0	163	0	223	2	283	0	343	0
44	0	104	0	164	0	224	0	284	1	344	0
45	0	105	0	165	0	225	0	285	1	345	0
46	0	106	0	166	0	226	1	286	0	346	0
47	0	107	0	167	0	227	0	287	0	347	0
48	1	108	0	168	0	228	0	288	1	348	0
49	0	109	0	169	0	229	1	289	0	349	1
50	0	110	0	170	0	230	0	290	0	350	0
51	0	111	0	171	0	231	0	291	0	351	1
52	0	112	0	172	0	232	0	292	0	352	0
53	0	113	0	173	0	233	0	293	0	353	0
54	0	114	0	174	1	234	0	294	0	354	0
55	0	115	0	175	0	235	0	295	0	355	0
56	0	116	0	176	1	236	0	296	0	356	0
57	0	117	0	177	1	237	0	297	2	357	1
58	0	118	1	178	0	238	0	298	0	358	0
59	0	119	0	179	0	239	0	299	0	359	0
60	0	120	0	180	0	240	0	300	0	360	0

NOTE---THE NUMBERS 1,2,3...48,49,50 REPRESENT THE INTERVALS 0-1,1-2,2-3...47-48,48-49,49-50 REPECTIVELY

ORIENTATION SUMMARY

TOTAL REENTRIES ANALYZED 61.0

	HEAD ON	SIDE ON	END ON
NUMBER	20.0	24.0	17.0
PERCENT	32.8	39.3	27.9

NOTE---HEAD ON REENTRY ORIENTATIONS ARE DEFINED AS .GE. 0 AND .LE. 45 DEGREES AND .GT. 315 AND .LT. 360 DEGREES
SIDE ON REENTRIES ARE DEFINED AS .GT. 45 AND .LE. 135 DEGREES AND .GT. 225 AND .LE. 315 DEGREES
END ON REENTRIES ARE DEFINED AS .GT. 135 AND .LE. 225 DEGREES

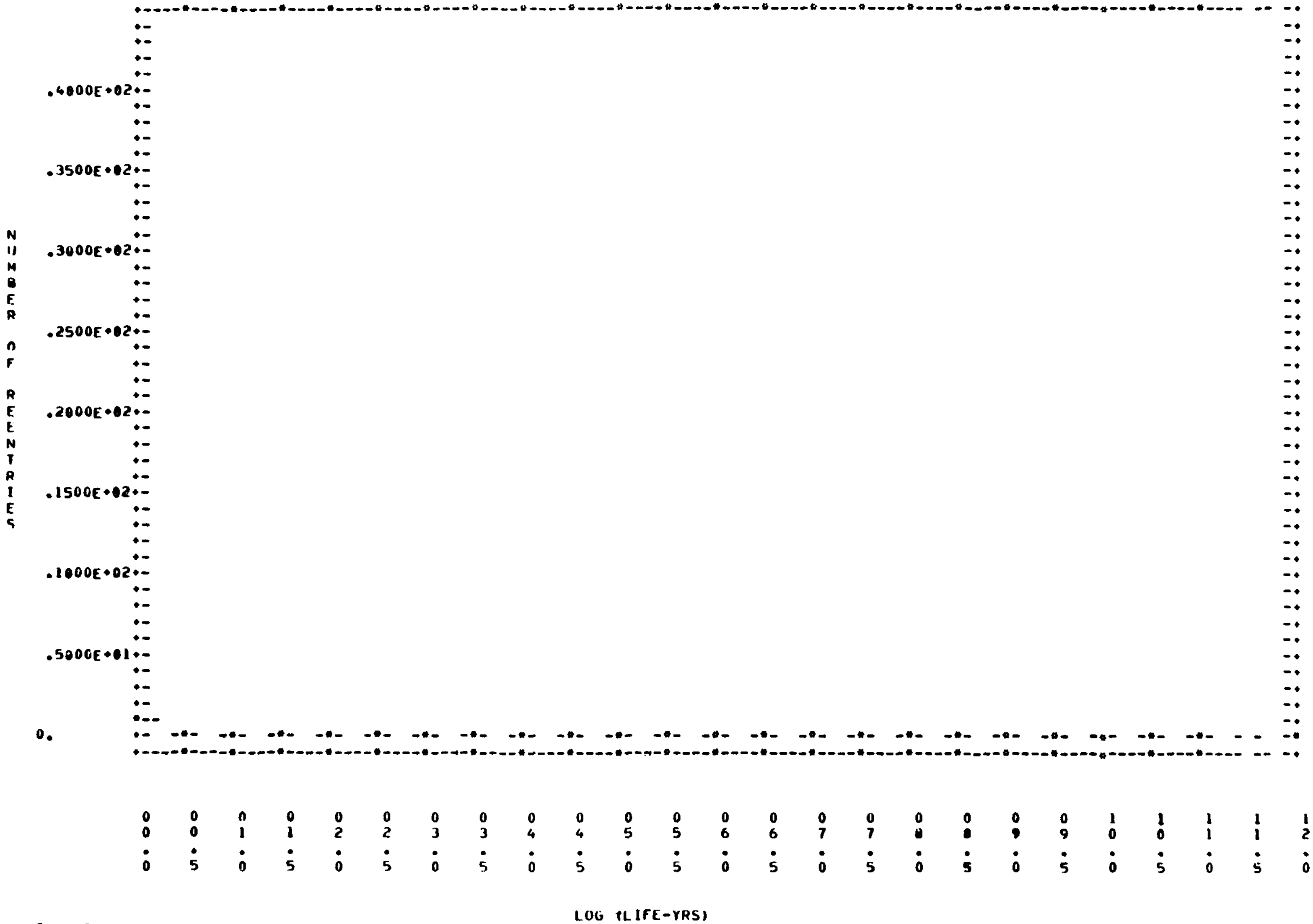
PROBABILITY OF ORBITAL DECAY TIMES

BALLISTIC COEF. .4748E+02KG/M**2

HOURS	DAYS	MONTHS	YEARS		CENTURIES
1 I 0.	1 I 0.	1 I 0.	1 I 0.	51 I 0.	1 I 0.
2 I 0.	2 I 0.	2 I 0.	2 I .17E-02	52 I 0.	2 I 0.
3 I 0.	3 I 0.	3 I 0.	3 I 0.	53 I 0.	3 I 0.
4 I 0.	4 I 0.	4 I 0.	4 I 0.	54 I 0.	4 I 0.
5 I 0.	5 I 0.	5 I 0.	5 I 0.	55 I 0.	5 I 0.
6 I 0.	6 I 0.	6 I 0.	6 I 0.	56 I 0.	6 I 0.
7 I 0.	7 I 0.	7 I 0.	7 I 0.	57 I 0.	7 I 0.
8 I 0.	8 I 0.	8 I 0.	8 I 0.	58 I 0.	8 I 0.
9 I 0.	9 I 0.	9 I 0.	9 I 0.	59 I 0.	9 I 0.
10 I 0.	10 I 0.	10 I 0.	10 I 0.	60 I 0.	10 I 0.
11 I 0.	11 I 0.	11 I 0.	11 I 0.	61 I 0.	11 I 0.
12 I 0.	12 I 0.	12 I 0.	12 I 0.	62 I 0.	12 I 0.
13 I 0.	13 I 0.		13 I 0.	63 I 0.	13 I 0.
14 I 0.	14 I 0.		14 I 0.	64 I 0.	14 I 0.
15 I 0.	15 I 0.		15 I 0.	65 I 0.	15 I 0.
16 I 0.	16 I 0.		16 I 0.	66 I 0.	16 I 0.
17 I 0.	17 I 0.		17 I 0.	67 I 0.	17 I 0.
18 I 0.	18 I 0.		18 I 0.	68 I 0.	18 I 0.
19 I 0.	19 I 0.		19 I 0.	69 I 0.	19 I 0.
20 I 0.	20 I 0.		20 I 0.	70 I 0.	20 I 0.
21 I 0.	21 I 0.		21 I 0.	71 I 0.	21 I 0.
22 I 0.	22 I 0.		22 I 0.	72 I 0.	22 I 0.
23 I 0.	23 I 0.		23 I 0.	73 I 0.	23 I 0.
24 I 0.	24 I 0.		24 I 0.	74 I 0.	24 I 0.
	25 I 0.		25 I 0.	75 I 0.	25 I 0.
	26 I 0.		26 I 0.	76 I 0.	26 I 0.
	27 I 0.		27 I 0.	77 I 0.	27 I 0.
	28 I 0.		28 I 0.	78 I 0.	28 I 0.
	29 I 0.		29 I 0.	79 I 0.	29 I 0.
	30 I 0.		30 I 0.	80 I 0.	30 I 0.
			31 I 0.	81 I 0.	31 I 0.
			32 I 0.	82 I 0.	32 I 0.
			33 I 0.	83 I 0.	33 I 0.
			34 I 0.	84 I 0.	34 I 0.
			35 I 0.	85 I 0.	35 I 0.
			36 I 0.	86 I 0.	36 I 0.
			37 I 0.	87 I 0.	37 I 0.
			38 I 0.	88 I 0.	38 I 0.
			39 I 0.	89 I 0.	39 I 0.
			40 I 0.	90 I 0.	40 I 0.
			41 I 0.	91 I 0.	41 I 0.
			42 I 0.	92 I 0.	42 I 0.
			43 I 0.	93 I 0.	43 I 0.
			44 I 0.	94 I 0.	44 I 0.
			45 I 0.	95 I 0.	45 I 0.
			46 I 0.	96 I 0.	46 I 0.
			47 I 0.	97 I 0.	47 I 0.
			48 I 0.	98 I 0.	48 I 0.
			49 I 0.	99 I 0.	49 I 0.
			50 I 0.	100 I 0.	50 I 0.
					GREATER THAN 50 I 0.

NOTE---THE NUMBERS 1,2,3...48,49,50 REPRESENT THE INTERVALS 0-1,1-2,2-3...47-48,48-49,49-50 RESPECTIVELY

TOTAL NUMBER OF REENTRIES ANALYZED 1



3 3
3

NOMINAL ABNORMAL BURN LOCATION (SECOND CENTAUR BURN)

FREQUENCY OF OCCURRENCE V-GAMMA MAP
FOR ALL REENTRY EVENTS CONSIDERED.
ENTRIES EXPRESSED IN UNITS OF 1 COUNTS PER BIN.

```
GAMMA (DEG)+-----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+
88.00-90.00+                                                                                                                           +
86.00-88.00+                                                                                                                           +
84.00-86.00+                                                                                                                           +
82.00-84.00+                                                                                                                           +
80.00-82.00+                                                                                                                           +
78.00-80.00+                                                                                                                           +
76.00-78.00+                                                                                                                           +
74.00-76.00+                                                                                                                           +
72.00-74.00+                                                                                                                           +
70.00-72.00+                                                                                                                           +
68.00-70.00+                                                                                                                           +
66.00-68.00+                                                                                                                           +
64.00-66.00+                                                                                                                           +
62.00-64.00+                                                                                                                           +
60.00-62.00+                                                                                                                           +
58.00-60.00+                                                                                                                           +
56.00-58.00+                                                                                                                           +
54.00-56.00+                                                                                                                           +
52.00-54.00+                                                                                                                           +
50.00-52.00+                                                                                                                           +
48.00-50.00+                                                                                                                           +
46.00-48.00+                                                                                                                           +
44.00-46.00+                                                                                                                           +
42.00-44.00+                                                                                                                           +
40.00-42.00+                                                                                                                           +
38.00-40.00+                                                                                                                           +
36.00-38.00+                                                                                                                           +
34.00-36.00+                                                                                                                           +
32.00-34.00+                                                                                                                           +
30.00-32.00+                                                                                                                           +
28.00-30.00+                                                                                                                           +
26.00-28.00+                                                                                                                           +
24.00-26.00+                                                                                                                           +
22.00-24.00+                                                                                                                           +
20.00-22.00+                                                                                                                           +
18.00-20.00+                                                                                                                           +
16.00-18.00+                                                                                                                           +
14.00-16.00+                                                                                                                           +
12.00-14.00+                                                                                                                           +
10.00-12.00+                                                                                                                           +
 8.00-10.00+                                                                                                                           +
 6.00- 8.00+                                                                                                                           +
 4.00- 6.00+                                                                                                                           +
 2.00- 4.00+                                                                                                                           +
  .00- 2.00+                                                                                                                           +
GAMMA (DEG)+-----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+
           1    1    1    1    1    1    2    2    2    2    2    2    2    2    2    2    3    3    3    3    3    3    3    3    3
           4    5    6    7    8    9    0    1    2    3    4    5    6    7    8    9    0    1    2    3    4    5    6    7    8
           .    .    .    .    .    .    .    .    .    .    .    .    .    .    .    .    .    .    .    .    .    .    .    .    .
           0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
           0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
```

ENTRY SPEED (KILOFEET PER SECOND)

PROBABILITY OF OCCURRENCE V-GAMMA MAP
FOR ALL REENTRY EVENTS CONSIDERED.

```
GAMMA (DEG)+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+--  -+
88.00-90.00+
86.00-88.00+
84.00-86.00+
82.00-84.00+
80.00-82.00+
78.00-80.00+
76.00-78.00+
74.00-76.00+
72.00-74.00+
70.00-72.00+
68.00-70.00+
66.00-68.00+
64.00-66.00+
62.00-64.00+
60.00-62.00+
58.00-60.00+
56.00-58.00+
54.00-56.00+
52.00-54.00+
50.00-52.00+
48.00-50.00+
46.00-48.00+
44.00-46.00+
42.00-44.00+
40.00-42.00+
38.00-40.00+
36.00-38.00+
34.00-36.00+
32.00-34.00+
30.00-32.00+
28.00-30.00+
26.00-28.00+
24.00-26.00+
22.00-24.00+
20.00-22.00+
18.00-20.00+
16.00-18.00+
14.00-16.00+
12.00-14.00+
10.00-12.00+
 8.00-10.00+
 6.00- 8.00+
 4.00- 6.00+
 2.00- 4.00+
  .00- 2.00+
GAMMA (DEG)+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+--  -+

            1     1     1     1     1     1     2     2     2     2     2     2     2     2     2     2     3     3     3     3     3     3     3     3     3
            4     5     6     7     8     9     0     1     2     3     4     5     6     7     8     9     0     1     2     3     4     5     6     7     8
            .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .
            0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
            0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
```

ENTRY SPEED (KILOFEET PER SECOND)

THE FOLLOWING DATA SUMMARIZES THE ENTIRE ACCIDENT FILE
ACCIDENT TITLE---NOMINAL ABNORMAL BURN LOCATION (SECOND CENTAUR BURN)

:::
MAXIUM AND MINIUM VALUES
VMIN = **********(KILOFEET PER SECOND)
VMAX = -.00000(KILOFEET PER SECOND)
GMIN = **********(DEGREES)
GMAX = -.00000(DEGREES)

FREQUENCY AND PROBABILISTIC DATA

FINAL TRAJECTORY	RESULT	NUMBER	PROBABILITY
ELLIPTIC	REENTRY	0	0.
	POWERED REENTRY	0	0.
	ORBIT	0	0.
PARABOLIC	REENTRY	0	0.
	POWERED REENTRY	0	0.
	ESCAPE	0	0.
HYPERBOLIC	REENTRY	0	0.
	POWERED REENTRY	0	0.
	ESCAPE	5	.3833000E+00
ALL	REENTRY	0	0.
	POWERED REENTRY	0	0.
	ESCAPE	5	.3833000E+00
TOTAL	TOTAL	5	.3833000E+00

OFF SCALE POINT SUMMARY

TOTAL NUMBER OF OFF SCALE POINTS = 0

TOTAL NUMBER OF OFF SCALE POWERED REENTRY POINTS = 0

MAX GAMMA ANGLE FOR OFF SCALE POINTS V = 0.00000 (KPS) GAMMA = -.00000 (DEGREES)

MAX VELOCITY FOR OFF SCALE POINTS V = -.00000 (KPS) GAMMA = 0.00000 (DEGREES)

MAX ANGLE FOR POWERED REENTRY OFF SCALE POINTS V = 0.00000 (KPS) GAMMA = -.00000 (DEGREES)

MAX VELOCITY FOR POWERED REENTRY OFF SCALE POINTS V = -.00000 (KPS) GAMMA = 0.00000 (DEGREES)

NOTE--- OFF SCALE POINTS ARE INCLUDED IN ALL ACCIDENT STATISTICS EXCEPT THE FREQUENCY AND PROBABILISTIC MAPS

FREQUENCY OF REENTRY TIMES

TIME FROM MALFUNCTION TO REENTRY

SECONDS		MINUTES		HOURS	
1	0	1	0	1	0
2	0	2	0	2	0
3	0	3	0	3	0
4	0	4	0	4	0
5	0	5	0	5	0
6	0	6	0	6	0
7	0	7	0	7	0
8	0	8	0	8	0
9	0	9	0	9	0
10	0	10	0	10	0
11	0	11	0	11	0
12	0	12	0	12	0
13	0	13	0	13	0
14	0	14	0	14	0
15	0	15	0	15	0
16	0	16	0	16	0
17	0	17	0	17	0
18	0	18	0	18	0
19	0	19	0	19	0
20	0	20	0	20	0
21	0	21	0	21	0
22	0	22	0	22	0
23	0	23	0	23	0
24	0	24	0	24	0
25	0	25	0	.GT.24	0
26	0	26	0		
27	0	27	0		
28	0	28	0		
29	0	29	0		
30	0	30	0		
31	0	31	0		
32	0	32	0		
33	0	33	0		
34	0	34	0		
35	0	35	0		
36	0	36	0		
37	0	37	0		
38	0	38	0		
39	0	39	0		
40	0	40	0		
41	0	41	0		
42	0	42	0		
43	0	43	0		
44	0	44	0		
45	0	45	0		
46	0	46	0		
47	0	47	0		
48	0	48	0		
49	0	49	0		
50	0	50	0		
51	0	51	0		
52	0	52	0		
53	0	53	0		
54	0	54	0		
55	0	55	0		
56	0	56	0		
57	0	57	0		
58	0	58	0		

BURNTIME LEFT DURING POWERED REENTRY

SECONDS		MINUTES		HOURS	
1	0	1	0	1	0
2	0	2	0	2	0
3	0	3	0	3	0
4	0	4	0	4	0
5	0	5	0	5	0
6	0	6	0	6	0
7	0	7	0	7	0
8	0	8	0	8	0
9	0	9	0	9	0
10	0	10	0	10	0
11	0	11	0	11	0
12	0	12	0	12	0
13	0	13	0	13	0
14	0	14	0	14	0
15	0	15	0	15	0
16	0	16	0	16	0
17	0	17	0	17	0
18	0	18	0	18	0
19	0	19	0	19	0
20	0	20	0	20	0
21	0	21	0	21	0
22	0	22	0	22	0
23	0	23	0	23	0
24	0	24	0	24	0
25	0	25	0	25	0
26	0	26	0		
27	0	27	0		
28	0	28	0		
29	0	29	0		
30	0	30	0		
31	0	31	0		
32	0	32	0		
33	0	33	0		
34	0	34	0		
35	0	35	0		
36	0	36	0		
37	0	37	0		
38	0	38	0		
39	0	39	0		
40	0	40	0		
41	0	41	0		
42	0	42	0		
43	0	43	0		
44	0	44	0		
45	0	45	0		
46	0	46	0		
47	0	47	0		
48	0	48	0		
49	0	49	0		
50	0	50	0		
51	0	51	0		
52	0	52	0		
53	0	53	0		
54	0	54	0		
55	0	55	0		
56	0	56	0		
57	0	57	0		
58	0	58	0		

FREQUENCY OF REENTRY ORIENTATION

1 I	0	61 I	0	121 I	0	181 I	0	241 I	0	301 I	0
2 I	0	62 I	0	122 I	0	182 I	0	242 I	0	302 I	0
3 I	0	63 I	0	123 I	0	183 I	0	243 I	0	303 I	0
4 I	0	64 I	0	124 I	0	184 I	0	244 I	0	304 I	0
5 I	0	65 I	0	125 I	0	185 I	0	245 I	0	305 I	0
6 I	0	66 I	0	126 I	0	186 I	0	246 I	0	306 I	0
7 I	0	67 I	0	127 I	0	187 I	0	247 I	0	307 I	0
8 I	0	68 I	0	128 I	0	188 I	0	248 I	0	308 I	0
9 I	0	69 I	0	129 I	0	189 I	0	249 I	0	309 I	0
10 I	0	70 I	0	130 I	0	190 I	0	250 I	0	310 I	0
11 I	0	71 I	0	131 I	0	191 I	0	251 I	0	311 I	0
12 I	0	72 I	0	132 I	0	192 I	0	252 I	0	312 I	0
13 I	0	73 I	0	133 I	0	193 I	0	253 I	0	313 I	0
14 I	0	74 I	0	134 I	0	194 I	0	254 I	0	314 I	0
15 I	0	75 I	0	135 I	0	195 I	0	255 I	0	315 I	0
16 I	0	76 I	0	136 I	0	196 I	0	256 I	0	316 I	0
17 I	0	77 I	0	137 I	0	197 I	0	257 I	0	317 I	0
18 I	0	78 I	0	138 I	0	198 I	0	258 I	0	318 I	0
19 I	0	79 I	0	139 I	0	199 I	0	259 I	0	319 I	0
20 I	0	80 I	0	140 I	0	200 I	0	260 I	0	320 I	0
21 I	0	81 I	0	141 I	0	201 I	0	261 I	0	321 I	0
22 I	0	82 I	0	142 I	0	202 I	0	262 I	0	322 I	0
23 I	0	83 I	0	143 I	0	203 I	0	263 I	0	323 I	0
24 I	0	84 I	0	144 I	0	204 I	0	264 I	0	324 I	0
25 I	0	85 I	0	145 I	0	205 I	0	265 I	0	325 I	0
26 I	0	86 I	0	146 I	0	206 I	0	266 I	0	326 I	0
27 I	0	87 I	0	147 I	0	207 I	0	267 I	0	327 I	0
28 I	0	88 I	0	148 I	0	208 I	0	268 I	0	328 I	0
29 I	0	89 I	0	149 I	0	209 I	0	269 I	0	329 I	0
30 I	0	90 I	0	150 I	0	210 I	0	270 I	0	330 I	0
31 I	0	91 I	0	151 I	0	211 I	0	271 I	0	331 I	0
32 I	0	92 I	0	152 I	0	212 I	0	272 I	0	332 I	0
33 I	0	93 I	0	153 I	0	213 I	0	273 I	0	333 I	0
34 I	0	94 I	0	154 I	0	214 I	0	274 I	0	334 I	0
35 I	0	95 I	0	155 I	0	215 I	0	275 I	0	335 I	0
36 I	0	96 I	0	156 I	0	216 I	0	276 I	0	336 I	0
37 I	0	97 I	0	157 I	0	217 I	0	277 I	0	337 I	0
38 I	0	98 I	0	158 I	0	218 I	0	278 I	0	338 I	0
39 I	0	99 I	0	159 I	0	219 I	0	279 I	0	339 I	0
40 I	0	100 I	0	160 I	0	220 I	0	280 I	0	340 I	0
41 I	0	101 I	0	161 I	0	221 I	0	281 I	0	341 I	0
42 I	0	102 I	0	162 I	0	222 I	0	282 I	0	342 I	0
43 I	0	103 I	0	163 I	0	223 I	0	283 I	0	343 I	0
44 I	0	104 I	0	164 I	0	224 I	0	284 I	0	344 I	0
45 I	0	105 I	0	165 I	0	225 I	0	285 I	0	345 I	0
46 I	0	106 I	0	166 I	0	226 I	0	286 I	0	346 I	0
47 I	0	107 I	0	167 I	0	227 I	0	287 I	0	347 I	0
48 I	0	108 I	0	168 I	0	228 I	0	288 I	0	348 I	0
49 I	0	109 I	0	169 I	0	229 I	0	289 I	0	349 I	0
50 I	0	110 I	0	170 I	0	230 I	0	290 I	0	350 I	0
51 I	0	111 I	0	171 I	0	231 I	0	291 I	0	351 I	0
52 I	0	112 I	0	172 I	0	232 I	0	292 I	0	352 I	0
53 I	0	113 I	0	173 I	0	233 I	0	293 I	0	353 I	0
54 I	0	114 I	0	174 I	0	234 I	0	294 I	0	354 I	0
55 I	0	115 I	0	175 I	0	235 I	0	295 I	0	355 I	0
56 I	0	116 I	0	176 I	0	236 I	0	296 I	0	356 I	0
57 I	0	117 I	0	177 I	0	237 I	0	297 I	0	357 I	0
58 I	0	118 I	0	178 I	0	238 I	0	298 I	0	358 I	0
59 I	0	119 I	0	179 I	0	239 I	0	299 I	0	359 I	0
60 I	0	120 I	0	180 I	0	240 I	0	300 I	0	360 I	0

NOTE---THE NUMBERS 1,2,3...48,49,50 REPRESENT THE INTERVALS 0-1,1-2,2-3...47-48,48-49,49-50 REPECTIVELY

ORIENTATION SUMMARY

TOTAL REENTRIES ANALYZED 0.0

	HEAD ON	SIDE ON	END ON
NUMBER	0.0	0.0	0.0
PERCENT	0.0	0.0	0.0

NOTE---HEAD ON REENTRY ORIENTATIONS ARE DEFINED AS .GE. 0 AND .LE. 45 DEGREES AND .GT. 315 AND .LT. 360 DEGREES
SIDE ON REENTRIES ARE DEFINED AS .GT. 45 AND .LE. 135 DEGREES AND .GT. 225 AND .LE. 315 DEGREES
END ON REENTRIES ARE DEFINED AS .GT. 135 AND .LE. 225 DEGREES

3 4
3

```
NOMINAL ABNORMAL BURN LOCATION (SECOND CENTAUR BURN)
RANDOMLY ORIENTED PROPULSION MODULE BURN (ABNORMAL CENTAUR BURN LOCATION)
PROBABILITY OF OCCURRENCE V-GAMMA MAP
FOR ALL REENTRY EVENTS CONSIDERED.

GAMMA (DEG)+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-- -+
88.00-90.00+
86.00-88.00+
84.00-86.00+
82.00-84.00+
80.00-82.00+
78.00-80.00+
76.00-78.00+
74.00-76.00+
72.00-74.00+
70.00-72.00+
68.00-70.00+
66.00-68.00+
64.00-66.00+
62.00-64.00+
60.00-62.00+
58.00-60.00+
56.00-58.00+
54.00-56.00+
52.00-54.00+
50.00-52.00+
48.00-50.00+
46.00-48.00+
44.00-46.00+
42.00-44.00+
40.00-42.00+
38.00-40.00+
36.00-38.00+
34.00-36.00+
32.00-34.00+
30.00-32.00+
28.00-30.00+
26.00-28.00+
24.00-26.00+
22.00-24.00+
20.00-22.00+
18.00-20.00+
16.00-18.00+
14.00-16.00+
12.00-14.00+
10.00-12.00+
 8.00-10.00+
 6.00- 8.00+
 4.00- 6.00+
 2.00- 4.00+
  .00- 2.00+
GAMMA (DEG)+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-- -+

           1     1     1     1     1     1     2     2     2     2     2     2     2     2     2     2     3     3     3     3     3     3     3     3     3
           4     5     6     7     8     9     0     1     2     3     4     5     6     7     8     9     0     1     2     3     4     5     6     7     8
           .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .
           0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
           0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0

                                        ENTRY SPEED (KILOFEET PER SECOND)
```

THE FOLLOWING DATA SUMMARIZES THE ENTIRE ACCIDENT FILE
ACCIDENT TITLE---NOMINAL ABNORMAL BURN LOCATION (SECOND CENTAUR BURN)
RANDOMLY ORIENTED PROPULSION MODULE BURN (ABNORMAL CENTAUR BURN LOCATION)

SUMMARY OF RESULTS FROM FILE 3
MAXIUM AND MINIUM VALUES
VMIN = **********(KILOFEET PER SECOND)
VMAX = -.00000(KILOFEET PER SECOND)
GMIN = **********(DEGREES)
GMAX = -.00000(DEGREES)

FREQUENCY AND PROBABILISTIC DATA

FINAL TRAJECTORY	RESULT	NUMBER	PROBABILITY
ELLIPTIC	REENTRY	0	0.
	POWERED REENTRY	0	0.
	ORBIT	0	0.
PARABOLIC	REENTRY	0	0.
	POWERED REENTRY	0	0.
	ESCAPE	0	0.
HYPERBOLIC	REENTRY	0	0.
	POWERED REENTRY	0	0.
	ESCAPE	35	.7999200E-05
ALL	REENTRY	0	0.
	POWERED REENTRY	0	0.
	ESCAPE	35	.7999200E-05
TOTAL	TOTAL	35	.7999200E-05

OFF SCALE POINT SUMMARY

TOTAL NUMBER OF OFF SCALE POINTS = 0

TOTAL NUMBER OF OFF SCALE POWERED REENTRY POINTS = 0

MAX GAMMA ANGLE FOR OFF SCALE POINTS	V =	0.00000 (KPS)	GAMMA =	-.00000 (DEGREES)
MAX VELOCITY FOR OFF SCALE POINTS	V =	-.00000 (KPS)	GAMMA =	0.00000 (DEGREES)
MAX ANGLE FOR POWERED REENTRY OFF SCALE POINTS	V =	0.00000 (KPS)	GAMMA =	-.00000 (DEGREES)
MAX VELOCITY FOR POWERED REENTRY OFF SCALE POINTS	V =	-.00000 (KPS)	GAMMA =	0.00000 (DEGREES)

NOTE--- OFF SCALE POINTS ARE INCLUDED IN ALL ACCIDENT STATISTICS EXCEPT THE FREQUENCY AND PROBABILISTIC MAPS

FREQUENCY OF REENTRY TIMES

TIME FROM MALFUNCTION TO REENTRY						BURNTIME LEFT DURING POWERED REENTRY					
SECONDS		MINUTES		HOURS		SECONDS		MINUTES		HOURS	
1	0	1	0	1	0	1	0	1	0	1	0
2	0	2	0	2	0	2	0	2	0	2	0
3	0	3	0	3	0	3	0	3	0	3	0
4	0	4	0	4	0	4	0	4	0	4	0
5	0	5	0	5	0	5	0	5	0	5	0
6	0	6	0	6	0	6	0	6	0	6	0
7	0	7	0	7	0	7	0	7	0	7	0
8	0	8	0	8	0	8	0	8	0	8	0
9	0	9	0	9	0	9	0	9	0	9	0
10	0	10	0	10	0	10	0	10	0	10	0
11	0	11	0	11	0	11	0	11	0	11	0
12	0	12	0	12	0	12	0	12	0	12	0
13	0	13	0	13	0	13	0	13	0	13	0
14	0	14	0	14	0	14	0	14	0	14	0
15	0	15	0	15	0	15	0	15	0	15	0
16	0	16	0	16	0	16	0	16	0	16	0
17	0	17	0	17	0	17	0	17	0	17	0
18	0	18	0	18	0	18	0	18	0	18	0
19	0	19	0	19	0	19	0	19	0	19	0
20	0	20	0	20	0	20	0	20	0	20	0
21	0	21	0	21	0	21	0	21	0	21	0
22	0	22	0	22	0	22	0	22	0	22	0
23	0	23	0	23	0	23	0	23	0	23	0
24	0	24	0	24	0	24	0	24	0	24	0
25	0	25	0	.GT.24	0	25	0	25	0	25	0
26	0	26	0			26	0	26	0		
27	0	27	0			27	0	27	0		
28	0	28	0			28	0	28	0		
29	0	29	0			29	0	29	0		
30	0	30	0			30	0	30	0		
31	0	31	0			31	0	31	0		
32	0	32	0			32	0	32	0		
33	0	33	0			33	0	33	0		
34	0	34	0			34	0	34	0		
35	0	35	0			35	0	35	0		
36	0	36	0			36	0	36	0		
37	0	37	0			37	0	37	0		
38	0	38	0			38	0	38	0		
39	0	39	0			39	0	39	0		
40	0	40	0			40	0	40	0		
41	0	41	0			41	0	41	0		
42	0	42	0			42	0	42	0		
43	0	43	0			43	0	43	0		
44	0	44	0			44	0	44	0		
45	0	45	0			45	0	45	0		
46	0	46	0			46	0	46	0		
47	0	47	0			47	0	47	0		
48	0	48	0			48	0	48	0		
49	0	49	0			49	0	49	0		
50	0	50	0			50	0	50	0		
51	0	51	0			51	0	51	0		
52	0	52	0			52	0	52	0		
53	0	53	0			53	0	53	0		
54	0	54	0			54	0	54	0		
55	0	55	0			55	0	55	0		
56	0	56	0			56	0	56	0		
57	0	57	0			57	0	57	0		
58	0	58	0			58	0	58	0		

FREQUENCY OF REENTRY ORIENTATION

1 I	0	61 I	0	121 I	0	181 I	0	241 I	0	301 I	0
2 I	0	62 I	0	122 I	0	182 I	0	242 I	0	302 I	0
3 I	0	63 I	0	123 I	0	183 I	0	243 I	0	303 I	0
4 I	0	64 I	0	124 I	0	184 I	0	244 I	0	304 I	0
5 I	0	65 I	0	125 I	0	185 I	0	245 I	0	305 I	0
6 I	0	66 I	0	126 I	0	186 I	0	246 I	0	306 I	0
7 I	0	67 I	0	127 I	0	187 I	0	247 I	0	307 I	0
8 I	0	68 I	0	128 I	0	188 I	0	248 I	0	308 I	0
9 I	0	69 I	0	129 I	0	189 I	0	249 I	0	309 I	0
10 I	0	70 I	0	130 I	0	190 I	0	250 I	0	310 I	0
11 I	0	71 I	0	131 I	0	191 I	0	251 I	0	311 I	0
12 I	0	72 I	0	132 I	0	192 I	0	252 I	0	312 I	0
13 I	0	73 I	0	133 I	0	193 I	0	253 I	0	313 I	0
14 I	0	74 I	0	134 I	0	194 I	0	254 I	0	314 I	0
15 I	0	75 I	0	135 I	0	195 I	0	255 I	0	315 I	0
16 I	0	76 I	0	136 I	0	196 I	0	256 I	0	316 I	0
17 I	0	77 I	0	137 I	0	197 I	0	257 I	0	317 I	0
18 I	0	78 I	0	138 I	0	198 I	0	258 I	0	318 I	0
19 I	0	79 I	0	139 I	0	199 I	0	259 I	0	319 I	0
20 I	0	80 I	0	140 I	0	200 I	0	260 I	0	320 I	0
21 I	0	81 I	0	141 I	0	201 I	0	261 I	0	321 I	0
22 I	0	82 I	0	142 I	0	202 I	0	262 I	0	322 I	0
23 I	0	83 I	0	143 I	0	203 I	0	263 I	0	323 I	0
24 I	0	84 I	0	144 I	0	204 I	0	264 I	0	324 I	0
25 I	0	85 I	0	145 I	0	205 I	0	265 I	0	325 I	0
26 I	0	86 I	0	146 I	0	206 I	0	266 I	0	326 I	0
27 I	0	87 I	0	147 I	0	207 I	0	267 I	0	327 I	0
28 I	0	88 I	0	148 I	0	208 I	0	268 I	0	328 I	0
29 I	0	89 I	0	149 I	0	209 I	0	269 I	0	329 I	0
30 I	0	90 I	0	150 I	0	210 I	0	270 I	0	330 I	0
31 I	0	91 I	0	151 I	0	211 I	0	271 I	0	331 I	0
32 I	0	92 I	0	152 I	0	212 I	0	272 I	0	332 I	0
33 I	0	93 I	0	153 I	0	213 I	0	273 I	0	333 I	0
34 I	0	94 I	0	154 I	0	214 I	0	274 I	0	334 I	0
35 I	0	95 I	0	155 I	0	215 I	0	275 I	0	335 I	0
36 I	0	96 I	0	156 I	0	216 I	0	276 I	0	336 I	0
37 I	0	97 I	0	157 I	0	217 I	0	277 I	0	337 I	0
38 I	0	98 I	0	158 I	0	218 I	0	278 I	0	338 I	0
39 I	0	99 I	0	159 I	0	219 I	0	279 I	0	339 I	0
40 I	0	100 I	0	160 I	0	220 I	0	280 I	0	340 I	0
41 I	0	101 I	0	161 I	0	221 I	0	281 I	0	341 I	0
42 I	0	102 I	0	162 I	0	222 I	0	282 I	0	342 I	0
43 I	0	103 I	0	163 I	0	223 I	0	283 I	0	343 I	0
44 I	0	104 I	0	164 I	0	224 I	0	284 I	0	344 I	0
45 I	0	105 I	0	165 I	0	225 I	0	285 I	0	345 I	0
46 I	0	106 I	0	166 I	0	226 I	0	286 I	0	346 I	0
47 I	0	107 I	0	167 I	0	227 I	0	287 I	0	347 I	0
48 I	0	108 I	0	168 I	0	228 I	0	288 I	0	348 I	0
49 I	0	109 I	0	169 I	0	229 I	0	289 I	0	349 I	0
50 I	0	110 I	0	170 I	0	230 I	0	290 I	0	350 I	0
51 I	0	111 I	0	171 I	0	231 I	0	291 I	0	351 I	0
52 I	0	112 I	0	172 I	0	232 I	0	292 I	0	352 I	0
53 I	0	113 I	0	173 I	0	233 I	0	293 I	0	353 I	0
54 I	0	114 I	0	174 I	0	234 I	0	294 I	0	354 I	0
55 I	0	115 I	0	175 I	0	235 I	0	295 I	0	355 I	0
56 I	0	116 I	0	176 I	0	236 I	0	296 I	0	356 I	0
57 I	0	117 I	0	177 I	0	237 I	0	297 I	0	357 I	0
58 I	0	118 I	0	178 I	0	238 I	0	298 I	0	358 I	0
59 I	0	119 I	0	179 I	0	239 I	0	299 I	0	359 I	0
60 I	0	120 I	0	180 I	0	240 I	0	300 I	0	360 I	0

NOTE---THE NUMBERS 1,2,3...48,49,50 REPRESENT THE INTERVALS 0-1,1-2,2-3...47-48,48-49,49-50 REPECTIVELY

ORIENTATION SUMMARY

TOTAL REENTRIES ANALYZED 0.0

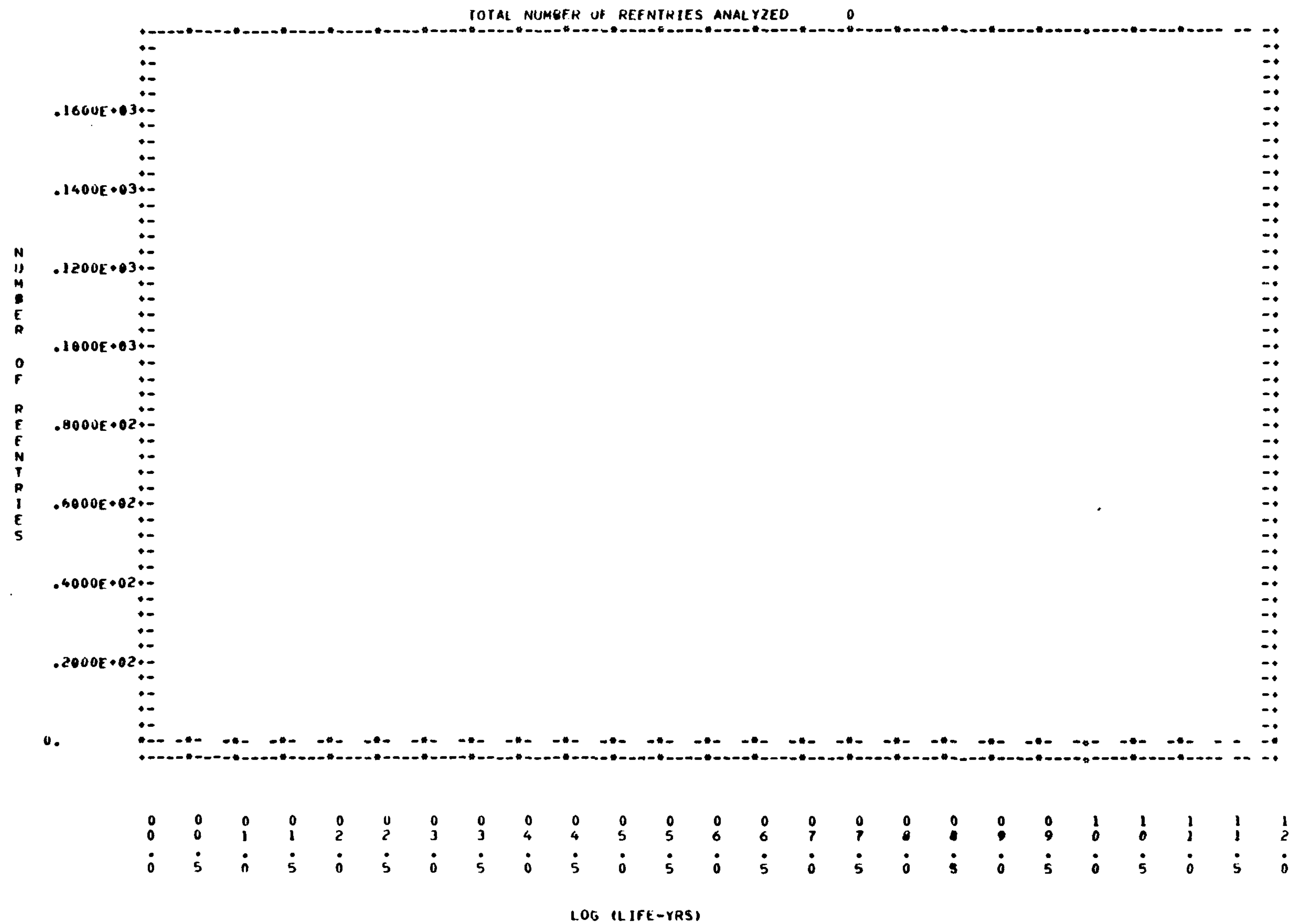
	HEAD ON	SIDE ON	END ON
NUMBER	0.0	0.0	0.0
PERCENT	0.0	0.0	0.0

NOTE---HEAD ON REENTRY ORIENTATIONS ARE DEFINED AS .GE. 0 AND .LE. 45 DEGREES AND .GT. 315 AND .LT. 360 DEGREES
SIDE ON REENTRIES ARE DEFINED AS .GT. 45 AND .LE. 135 DEGREES AND .GT. 225 AND .LE. 315 DEGREES
END ON REENTRIES ARE DEFINED AS .GT. 135 AND .LE. 225 DEGREES

PROBABILITY OF ORBITAL DECAY TIMES BALLISTIC COEF. .4748E+02KG/M**2

HOURS	DAYS	MONTHS	YEARS	YEARS	CENTURIES
1 I 0.	1 I 0.	1 I 0.	1 I 0.	51 I 0.	1 I 0.
2 I 0.	2 I 0.	2 I 0.	2 I 0.	52 I 0.	2 I 0.
3 I 0.	3 I 0.	3 I 0.	3 I 0.	53 I 0.	3 I 0.
4 I 0.	4 I 0.	4 I 0.	4 I 0.	54 I 0.	4 I 0.
5 I 0.	5 I 0.	5 I 0.	5 I 0.	55 I 0.	5 I 0.
6 I 0.	6 I 0.	6 I 0.	6 I 0.	56 I 0.	6 I 0.
7 I 0.	7 I 0.	7 I 0.	7 I 0.	57 I 0.	7 I 0.
8 I 0.	8 I 0.	8 I 0.	8 I 0.	58 I 0.	8 I 0.
9 I 0.	9 I 0.	9 I 0.	9 I 0.	59 I 0.	9 I 0.
10 I 0.	10 I 0.	10 I 0.	10 I 0.	60 I 0.	10 I 0.
11 I 0.	11 I 0.	11 I 0.	11 I 0.	61 I 0.	11 I 0.
12 I 0.	12 I 0.	12 I 0.	12 I 0.	62 I 0.	12 I 0.
13 I 0.	13 I 0.		13 I 0.	63 I 0.	13 I 0.
14 I 0.	14 I 0.		14 I 0.	64 I 0.	14 I 0.
15 I 0.	15 I 0.		15 I 0.	65 I 0.	15 I 0.
16 I 0.	16 I 0.		16 I 0.	66 I 0.	16 I 0.
17 I 0.	17 I 0.		17 I 0.	67 I 0.	17 I 0.
18 I 0.	18 I 0.		18 I 0.	68 I 0.	18 I 0.
19 I 0.	19 I 0.		19 I 0.	69 I 0.	19 I 0.
20 I 0.	20 I 0.		20 I 0.	70 I 0.	20 I 0.
21 I 0.	21 I 0.		21 I 0.	71 I 0.	21 I 0.
22 I 0.	22 I 0.		22 I 0.	72 I 0.	22 I 0.
23 I 0.	23 I 0.		23 I 0.	73 I 0.	23 I 0.
24 I 0.	24 I 0.		24 I 0.	74 I 0.	24 I 0.
	25 I 0.		25 I 0.	75 I 0.	25 I 0.
	26 I 0.		26 I 0.	76 I 0.	26 I 0.
	27 I 0.		27 I 0.	77 I 0.	27 I 0.
	28 I 0.		28 I 0.	78 I 0.	28 I 0.
	29 I 0.		29 I 0.	79 I 0.	29 I 0.
	30 I 0.		30 I 0.	80 I 0.	30 I 0.
			31 I 0.	81 I 0.	31 I 0.
			32 I 0.	82 I 0.	32 I 0.
			33 I 0.	83 I 0.	33 I 0.
			34 I 0.	84 I 0.	34 I 0.
			35 I 0.	85 I 0.	35 I 0.
			36 I 0.	86 I 0.	36 I 0.
			37 I 0.	87 I 0.	37 I 0.
			38 I 0.	88 I 0.	38 I 0.
			39 I 0.	89 I 0.	39 I 0.
			40 I 0.	90 I 0.	40 I 0.
			41 I 0.	91 I 0.	41 I 0.
			42 I 0.	92 I 0.	42 I 0.
			43 I 0.	93 I 0.	43 I 0.
			44 I 0.	94 I 0.	44 I 0.
			45 I 0.	95 I 0.	45 I 0.
			46 I 0.	96 I 0.	46 I 0.
			47 I 0.	97 I 0.	47 I 0.
			48 I 0.	98 I 0.	48 I 0.
			49 I 0.	99 I 0.	49 I 0.
			50 I 0.	100 I 0.	50 I 0.
					GREATER THAN 50 I 0.

NOTE---THE NUMBERS 1,2,3...48,49,50 REPRESENT THE INTERVALS 0-1,1-2,2-3...47-48,48-49,49-50 RESPECTIVELY


TOTAL NUMBER OF REENTRIES ANALYZED 0
NUMBER OF REENTRIES
.1600E+03
.1400E+03
.1200E+03
.1000E+03
.8000E+02
.6000E+02
.4000E+02
.2000E+02
0.
00.0 00.5 01.0 01.5 02.0 02.5 03.0 03.5 04.0 04.5 05.0 05.5 06.0 06.5 07.0 07.5 08.0 08.5 09.0 09.5 10.0 10.5 11.0 11.5 12.0
LOG (LIFE-YRS)

1 4
1

78

FREQUENCY OF OCCURRENCE V-GAMMA MAP
FOR ALL REENTRY EVENTS CONSIDERED.
ENTRIES EXPRESSED IN UNITS OF   1 COUNTS PER BIN.

```
GAMMA (DEG)+-----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+
88.00-90.00+                                                                                                                            +
86.00-88.00+                                                                                                                            +
84.00-86.00+                                                                                                                            +
82.00-84.00+                                                                                                                            +
80.00-82.00+                                                                                                                            +
78.00-80.00+                                                                                                                            +
76.00-78.00+                                                                                                                            +
74.00-76.00+                                                                                                                            +
72.00-74.00+                                                                                                                            +
70.00-72.00+                                                                                                                            +
68.00-70.00+                                                                                                                            +
66.00-68.00+                                                                                                                            +
64.00-66.00+                                                                                                                            +
62.00-64.00+                                                                                                                            +
60.00-62.00+                                                                                                                            +
58.00-60.00+                                                                                                                            +
56.00-58.00+                                                                                                                            +
54.00-56.00+                                                                                                                            +
52.00-54.00+                                                                                                                            +
50.00-52.00+                                                                                                                            +
48.00-50.00+                                                                                                                            +
46.00-48.00+                                                                                                                            +
44.00-46.00+                                                                                                                            +
42.00-44.00+                                                                                                                            +
40.00-42.00+                                                                                                                            +
38.00-40.00+                                                                                                                            +
36.00-38.00+                                                                                                                            +
34.00-36.00+                                                                                                                            +
32.00-34.00+                                                                                                                            +
30.00-32.00+                                                                                                                            +
28.00-30.00+                                                                                                                            +
26.00-28.00+                                                                                                                            +
24.00-26.00+                                                                                                                            +
22.00-24.00+                                                                                                                            +
20.00-22.00+                                                                                                                            +
18.00-20.00+                                                                                                                            +
16.00-18.00+                                                                                                                            +
14.00-16.00+                                                                                                                            +
12.00-14.00+                                                                                                                            +
10.00-12.00+                                                                                                                            +
 8.00-10.00+                                                                                                                            +
 6.00- 8.00+                                                                                                                            +
 4.00- 6.00+                                                                                                                            +
 2.00- 4.00+                                                                                                                            +
  .00- 2.00+                                                                                                                            +
GAMMA (DEG)+-----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+

           1    1    1    1    1    1    2    2    2    2    2    2    2    2    2    2    3    3    3    3    3    3    3    3    3
           4    5    6    7    8    9    0    1    2    3    4    5    6    7    8    9    0    1    2    3    4    5    6    7    8
           .    .    .    .    .    .    .    .    .    .    .    .    .    .    .    .    .    .    .    .    .    .    .    .    .
           0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
           0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
```

ENTRY SPEED (KILOFEET PER SECOND)

```
[illegible] TIME CORRECT ORIENTATION BURN (SECOND CENTAUR BURN)

[illegible] OF OCCURRENCE V-GAMMA MAP
[illegible] REENTRY EVENTS CONSIDERED.

[illegible] (DEG) +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+--+
[illegible]+
[illegible]+
[illegible]+
[illegible]+
[illegible]+
[illegible]+
[illegible]+
[illegible]+
72.00-74.00+
70.00-72.00+
68.00-70.00+
66.00-68.00+
64.00-66.00+
62.00-64.00+
60.00-62.00+
58.00-60.00+
56.00-58.00+
54.00-56.00+
52.00-54.00+
50.00-52.00+
48.00-50.00+
46.00-48.00+
44.00-46.00+
42.00-44.00+
40.00-42.00+
38.00-40.00+
36.00-38.00+
34.00-36.00+
32.00-34.00+
30.00-32.00+
28.00-30.00+
26.00-28.00+
24.00-26.00+
22.00-24.00+
20.00-22.00+
18.00-20.00+
16.00-18.00+
14.00-16.00+
12.00-14.00+
10.00-12.00+
 8.00-10.00+
 6.00- 8.00+
 4.00- 6.00+
 2.00- 4.00+
  .00- 2.00+
GAMMA (DEG) +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+--+
            14.00 15.00 16.00 17.00 18.00 19.00 20.00 21.00 22.00 23.00 24.00 25.00 26.00 27.00 28.00 29.00 30.00 31.00 32.00 33.00 34.00 35.00 36.00 37.00 38.00

                                        ENTRY SPEED (KILOFEET PER SECOND)
```

```
THE FOLLOWING DATA SUMMARIZES THE ENTIRE ACCIDENT FILE
ACCIDENT TITLE---SHORT ON TIME CORRECT ORIENTATION BURN (SECOND CENTAUR BURN)

:::
MAXIUM AND MINIUM VALUES
VMIN = **********(KILOFEET PER SECOND)
VMAX =    -.00000(KILOFEET PER SECOND)
GMIN = **********(DEGREES)
GMAX =    -.00000(DEGREES)
```

FREQUENCY AND PROBABILISTIC DATA

FINAL TRAJECTORY	RESULT	NUMBER	PROBABILITY
ELLIPTIC	REENTRY	0	0.
	POWERED REENTRY	0	0.
	ORBIT	4	.2666400E+00
PARABOLIC	REENTRY	0	0.
	POWERED REENTRY	0	0.
	ESCAPE	0	0.
HYPERBOLIC	REENTRY	0	0.
	POWERED REENTRY	0	0.
	ESCAPE	1	.6666000E-01
ALL	REENTRY	0	0.
	POWERED REENTRY	0	0.
	ESCAPE	5	.3333000E+00
TOTAL	TOTAL	5	.3333000E+00

OFF SCALE POINT SUMMARY

```
TOTAL NUMBER OF OFF SCALE POINTS =      0

TOTAL NUMBER OF OFF SCALE POWERED REENTRY POINTS =      0

MAX GAMMA ANGLE FOR OFF SCALE POINTS            V =   0.00000 (KPS)   GAMMA =   -.00000 (DEGREES)

MAX VELOCITY FOR OFF SCALE POINTS               V =   -.00000 (KPS)   GAMMA =   0.00000 (DEGREES)

MAX ANGLE FOR POWERED REENTRY OFF SCALE POINTS  V =   0.00000 (KPS)   GAMMA =   -.00000 (DEGREES)

MAX VELOCITY FOR POWERED REENTRY OFF SCALE POINTS  V =   -.00000 (KPS)   GAMMA =   0.00000 (DEGREES)
```

NOTE--- OFF SCALE POINTS ARE INCLUDED IN ALL ACCIDENT STATISTICS EXCEPT THE FREQUENCY AND PROBABILISTIC MAPS

FREQUENCY OF REENTRY TIMES

TIME FROM MALFUNCTION TO REENTRY SECONDS		MINUTES		HOURS		BURNTIME LEFT DURING POWERED REENTRY SECONDS		MINUTES		HOURS	
1	0	1	0	1	0	1	0	1	0	1	0
2	0	2	0	2	0	2	0	2	0	2	0
3	0	3	0	3	0	3	0	3	0	3	0
4	0	4	0	4	0	4	0	4	0	4	0
5	0	5	0	5	0	5	0	5	0	5	0
6	0	6	0	6	0	6	0	6	0	6	0
7	0	7	0	7	0	7	0	7	0	7	0
8	0	8	0	8	0	8	0	8	0	8	0
9	0	9	0	9	0	9	0	9	0	9	0
10	0	10	0	10	0	10	0	10	0	10	0
11	0	11	0	11	0	11	0	11	0	11	0
12	0	12	0	12	0	12	0	12	0	12	0
13	0	13	0	13	0	13	0	13	0	13	0
14	0	14	0	14	0	14	0	14	0	14	0
15	0	15	0	15	0	15	0	15	0	15	0
16	0	16	0	16	0	16	0	16	0	16	0
17	0	17	0	17	0	17	0	17	0	17	0
18	0	18	0	18	0	18	0	18	0	18	0
19	0	19	0	19	0	19	0	19	0	19	0
20	0	20	0	20	0	20	0	20	0	20	0
21	0	21	0	21	0	21	0	21	0	21	0
22	0	22	0	22	0	22	0	22	0	22	0
23	0	23	0	23	0	23	0	23	0	23	0
24	0	24	0	24	0	24	0	24	0	24	0
25	0	25	0	.GT.24	0	25	0	25	0	25	0
26	0	26	0			26	0	26	0		
27	0	27	0			27	0	27	0		
28	0	28	0			28	0	28	0		
29	0	29	0			29	0	29	0		
30	0	30	0			30	0	30	0		
31	0	31	0			31	0	31	0		
32	0	32	0			32	0	32	0		
33	0	33	0			33	0	33	0		
34	0	34	0			34	0	34	0		
35	0	35	0			35	0	35	0		
36	0	36	0			36	0	36	0		
37	0	37	0			37	0	37	0		
38	0	38	0			38	0	38	0		
39	0	39	0			39	0	39	0		
40	0	40	0			40	0	40	0		
41	0	41	0			41	0	41	0		
42	0	42	0			42	0	42	0		
43	0	43	0			43	0	43	0		
44	0	44	0			44	0	44	0		
45	0	45	0			45	0	45	0		
46	0	46	0			46	0	46	0		
47	0	47	0			47	0	47	0		
48	0	48	0			48	0	48	0		
49	0	49	0			49	0	49	0		
50	0	50	0			50	0	50	0		
51	0	51	0			51	0	51	0		
52	0	52	0			52	0	52	0		
53	0	53	0			53	0	53	0		
54	0	54	0			54	0	54	0		
55	0	55	0			55	0	55	0		
56	0	56	0			56	0	56	0		
57	0	57	0			57	0	57	0		
58	0	58	0			58	0	58	0		

FREQUENCY OF REENTRY ORIENTATION

1 I	0	61 I	0	121 I	0	181 I	0	241 I	0	301 I	0
2 I	0	62 I	0	122 I	0	182 I	0	242 I	0	302 I	0
3 I	0	63 I	0	123 I	0	183 I	0	243 I	0	303 I	0
4 I	0	64 I	0	124 I	0	184 I	0	244 I	0	304 I	0
5 I	0	65 I	0	125 I	0	185 I	0	245 I	0	305 I	0
6 I	0	66 I	0	126 I	0	186 I	0	246 I	0	306 I	0
7 I	0	67 I	0	127 I	0	187 I	0	247 I	0	307 I	0
8 I	0	68 I	0	128 I	0	188 I	0	248 I	0	308 I	0
9 I	0	69 I	0	129 I	0	189 I	0	249 I	0	309 I	0
10 I	0	70 I	0	130 I	0	190 I	0	250 I	0	310 I	0
11 I	0	71 I	0	131 I	0	191 I	0	251 I	0	311 I	0
12 I	0	72 I	0	132 I	0	192 I	0	252 I	0	312 I	0
13 I	0	73 I	0	133 I	0	193 I	0	253 I	0	313 I	0
14 I	0	74 I	0	134 I	0	194 I	0	254 I	0	314 I	0
15 I	0	75 I	0	135 I	0	195 I	0	255 I	0	315 I	0
16 I	0	76 I	0	136 I	0	196 I	0	256 I	0	316 I	0
17 I	0	77 I	0	137 I	0	197 I	0	257 I	0	317 I	0
18 I	0	78 I	0	138 I	0	198 I	0	258 I	0	318 I	0
19 I	0	79 I	0	139 I	0	199 I	0	259 I	0	319 I	0
20 I	0	80 I	0	140 I	0	200 I	0	260 I	0	320 I	0
21 I	0	81 I	0	141 I	0	201 I	0	261 I	0	321 I	0
22 I	0	82 I	0	142 I	0	202 I	0	262 I	0	322 I	0
23 I	0	83 I	0	143 I	0	203 I	0	263 I	0	323 I	0
24 I	0	84 I	0	144 I	0	204 I	0	264 I	0	324 I	0
25 I	0	85 I	0	145 I	0	205 I	0	265 I	0	325 I	0
26 I	0	86 I	0	146 I	0	206 I	0	266 I	0	326 I	0
27 I	0	87 I	0	147 I	0	207 I	0	267 I	0	327 I	0
28 I	0	88 I	0	148 I	0	208 I	0	268 I	0	328 I	0
29 I	0	89 I	0	149 I	0	209 I	0	269 I	0	329 I	0
30 I	0	90 I	0	150 I	0	210 I	0	270 I	0	330 I	0
31 I	0	91 I	0	151 I	0	211 I	0	271 I	0	331 I	0
32 I	0	92 I	0	152 I	0	212 I	0	272 I	0	332 I	0
33 I	0	93 I	0	153 I	0	213 I	0	273 I	0	333 I	0
34 I	0	94 I	0	154 I	0	214 I	0	274 I	0	334 I	0
35 I	0	95 I	0	155 I	0	215 I	0	275 I	0	335 I	0
36 I	0	96 I	0	156 I	0	216 I	0	276 I	0	336 I	0
37 I	0	97 I	0	157 I	0	217 I	0	277 I	0	337 I	0
38 I	0	98 I	0	158 I	0	218 I	0	278 I	0	338 I	0
39 I	0	99 I	0	159 I	0	219 I	0	279 I	0	339 I	0
40 I	0	100 I	0	160 I	0	220 I	0	280 I	0	340 I	0
41 I	0	101 I	0	161 I	0	221 I	0	281 I	0	341 I	0
42 I	0	102 I	0	162 I	0	222 I	0	282 I	0	342 I	0
43 I	0	103 I	0	163 I	0	223 I	0	283 I	0	343 I	0
44 I	0	104 I	0	164 I	0	224 I	0	284 I	0	344 I	0
45 I	0	105 I	0	165 I	0	225 I	0	285 I	0	345 I	0
46 I	0	106 I	0	166 I	0	226 I	0	286 I	0	346 I	0
47 I	0	107 I	0	167 I	0	227 I	0	287 I	0	347 I	0
48 I	0	108 I	0	168 I	0	228 I	0	288 I	0	348 I	0
49 I	0	109 I	0	169 I	0	229 I	0	289 I	0	349 I	0
50 I	0	110 I	0	170 I	0	230 I	0	290 I	0	350 I	0
51 I	0	111 I	0	171 I	0	231 I	0	291 I	0	351 I	0
52 I	0	112 I	0	172 I	0	232 I	0	292 I	0	352 I	0
53 I	0	113 I	0	173 I	0	233 I	0	293 I	0	353 I	0
54 I	0	114 I	0	174 I	0	234 I	0	294 I	0	354 I	0
55 I	0	115 I	0	175 I	0	235 I	0	295 I	0	355 I	0
56 I	0	116 I	0	176 I	0	236 I	0	296 I	0	356 I	0
57 I	0	117 I	0	177 I	0	237 I	0	297 I	0	357 I	0
58 I	0	118 I	0	178 I	0	238 I	0	298 I	0	358 I	0
59 I	0	119 I	0	179 I	0	239 I	0	299 I	0	359 I	0
60 I	0	120 I	0	180 I	0	240 I	0	300 I	0	360 I	0

NOTE---THE NUMBERS 1,2,3...48,49,50 REPRESENT THE INTERVALS 0-1,1-2,2-3...47-48,48-49,49-50 REPECTIVELY

ORIENTATION SUMMARY

TOTAL REENTRIES ANALYZED 0.0

	HEAD ON	SIDE ON	END ON
NUMBER	0.0	0.0	0.0
PERCENT	0.0	0.0	0.0

NOTE---HEAD ON REENTRY ORIENTATIONS ARE DEFINED AS .GE. 0 AND .LE. 45 DEGREES AND .GT. 315 AND .LT. 360 DEGREES
SIDE ON REENTRIES ARE DEFINED AS .GT. 45 AND .LE. 135 DEGREES AND .GT. 225 AND .LE. 315 DEGREES
END ON REENTRIES ARE DEFINED AS .GT. 135 AND .LE. 225 DEGREES

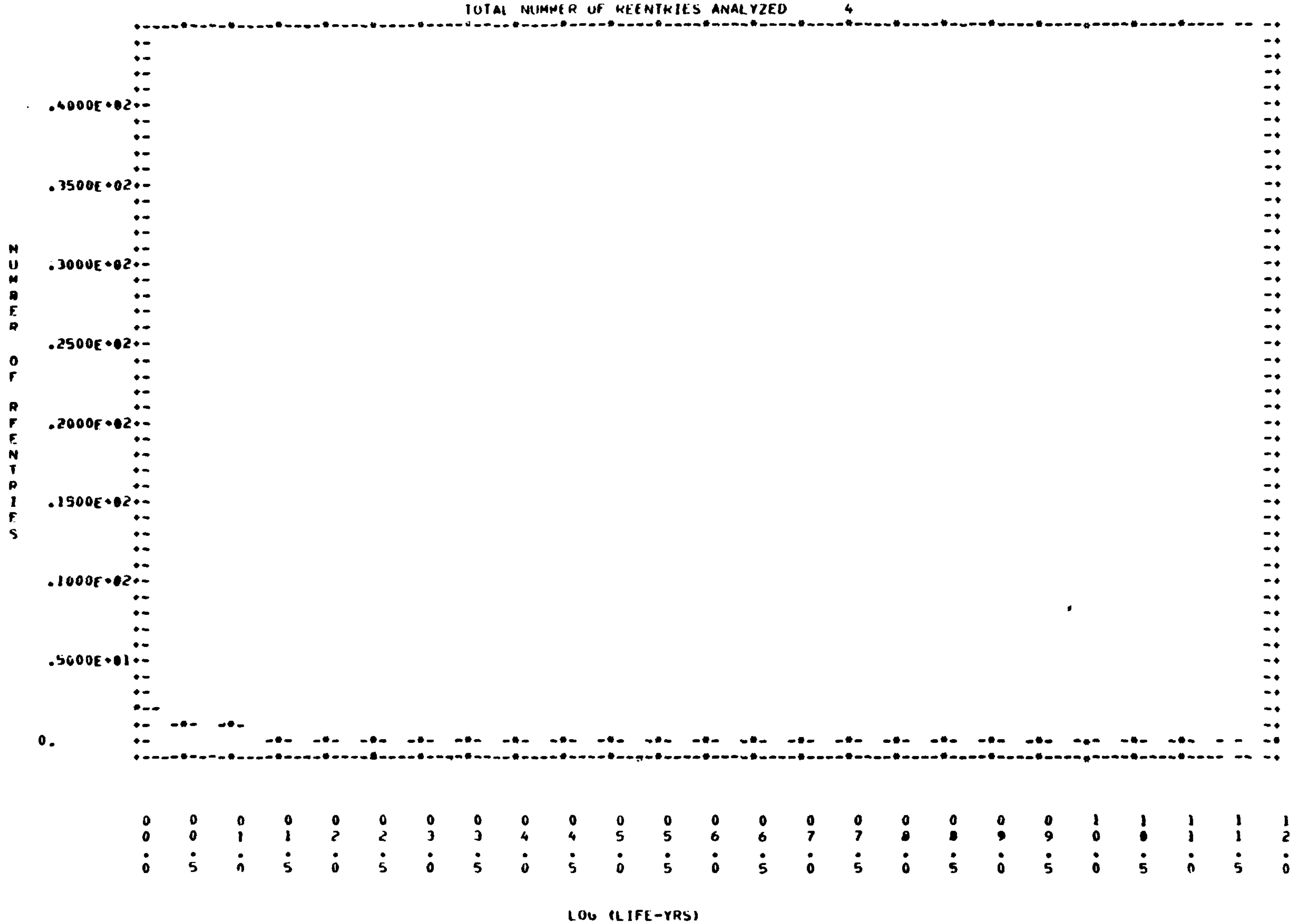
[illegible] BALLISTIC COEF. .2532E+03KG/M**2

	HOURS	DAYS	MONTHS	YEARS		YEARS	CENTURIES
1	0.	0.	0.	.67E-01	51	0.	0.
2	0.	0.	0.	0.	52	0.	0.
3	0.	0.	0.	0.	53	0.	0.
4	0.	0.	.67E-01	.67E-01	54	0.	0.
5	0.	0.	0.	0.	55	0.	0.
6	0.	0.	0.	0.	56	0.	0.
7	0.	0.	0.	0.	57	0.	0.
8	0.	0.	0.	0.	58	0.	0.
9	0.	0.	0.	0.	59	0.	0.
10	0.	0.	0.	0.	60	0.	0.
11	0.	0.	0.	0.	61	0.	0.
12	0.	0.	0.	.67E-01	62	0.	0.
13	0.	0.		0.	63	0.	0.
14	0.	0.		0.	64	0.	0.
15	0.	0.		0.	65	0.	0.
16	0.	0.		0.	66	0.	0.
17	0.	0.		0.	67	0.	0.
18	0.	0.		0.	68	0.	0.
19	0.	0.		0.	69	0.	0.
20	0.	0.		0.	70	0.	0.
21	0.	0.		0.	71	0.	0.
22	0.	0.		0.	72	0.	0.
23	0.	0.		0.	73	0.	0.
24	0.	0.		0.	74	0.	0.
25		0.		0.	75	0.	0.
26		0.		0.	76	0.	0.
27		0.		0.	77	0.	0.
28		0.		0.	78	0.	0.
29		0.		0.	79	0.	0.
30		0.		0.	80	0.	0.
31				0.	81	0.	0.
32				0.	82	0.	0.
33				0.	83	0.	0.
34				0.	84	0.	0.
35				0.	85	0.	0.
36				0.	86	0.	0.
37				0.	87	0.	0.
38				0.	88	0.	0.
39				0.	89	0.	0.
40				0.	90	0.	0.
41				0.	91	0.	0.
42				0.	92	0.	0.
43				0.	93	0.	0.
44				0.	94	0.	0.
45				0.	95	0.	0.
46				0.	96	0.	0.
47				0.	97	0.	0.
48				0.	98	0.	0.
49				0.	99	0.	0.
50				0.	100	0.	0.

GREATER THAN 50 I 0.

NOTE---THE NUMBERS 1,2,3...48,49,50 REPRESENT THE INTERVALS 0-1,1-2,2-3...47-48,48-49,49-50 RESPECTIVELY

TOTAL NUMBER OF REENTRIES ANALYZED 4



FREQUENCY OF OCCURRENCE V-GAMMA MAP
FOR ALL REENTRY EVENTS CONSIDERED.
ENTRIES EXPRESSED IN UNITS OF 1 COUNTS PER BIN.

GAMMA (DEG)	14.00	15.00	16.00	17.00	18.00	19.00	20.00	21.00	22.00	23.00	24.00	25.00	26.00	27.00	28.00	29.00	30.00	31.00	32.00	33.00	34.00	35.00	36.00	37.00	38.00
88.00-90.00																									
86.00-88.00																									
84.00-86.00																									
82.00-84.00																									
80.00-82.00																									
78.00-80.00																									
76.00-78.00																									
74.00-76.00																									
72.00-74.00																									
70.00-72.00																									
68.00-70.00																									
66.00-68.00																									
64.00-66.00																									
62.00-64.00																									
60.00-62.00																									
58.00-60.00																									
56.00-58.00																									
54.00-56.00					1	1																			
52.00-54.00					1																				
50.00-52.00						1				1															
48.00-50.00										1	2														
46.00-48.00																									
44.00-46.00															2										
42.00-44.00																2									
40.00-42.00																									
38.00-40.00																			2	1					
36.00-38.00																				1					
34.00-36.00												1				1									
32.00-34.00									1			1			1			1					2	1	
30.00-32.00									1					1			1	1						1	
28.00-30.00											1			1			1			1	1				
26.00-28.00						1					1									1	1		1		
24.00-26.00						1																	1	1	
22.00-24.00																								1	
20.00-22.00								2																	
18.00-20.00																									
16.00-18.00																									
14.00-16.00																									
12.00-14.00				2																					
10.00-12.00							2																		
8.00-10.00																				1					
6.00- 8.00																									
4.00- 6.00																				1		1			
2.00- 4.00																									
.00- 2.00													5												
GAMMA (DEG)																									

ENTRY SPEED (KILOFEET PER SECOND)

VOYAGER SAMPLE V-GAMMA PROBLEM

PROBABILITY OF OCCURRENCE V-GAMMA MAP
FOR ALL REENTRY EVENTS CONSIDERED.

```
GAMMA (DEG)+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+
88.00-90.00+
86.00-88.00+
84.00-86.00+
82.00-84.00+
80.00-82.00+
78.00-80.00+
76.00-78.00+
74.00-76.00+
72.00-74.00+
70.00-72.00+
68.00-70.00+
66.00-68.00+
64.00-66.00+
62.00-64.00+
60.00-62.00+
58.00-60.00+
56.00-58.00+
54.00-56.00+                2 -3 2 -3
52.00-54.00+                2 -3
50.00-52.00+                     2 -3                2 -3
48.00-50.00+                                         2 -3 3 -3
46.00-48.00+
44.00-46.00+                                                                  3 -3
42.00-44.00+                                                                       3 -3
40.00-42.00+
38.00-40.00+                                                                                      3 -3 2 -3
36.00-38.00+                                                                                           2 -3
34.00-36.00+                                                   2 -3                2 -3
32.00-34.00+                                    2 -3           2 -3           2 -3           2 -3                     3 -3 2 -3
30.00-32.00+                                    2 -3                     2 -3           2 -3 2 -3                          2 -3
28.00-30.00+                                              2 -3           2 -3           2 -3           2 -3 2 -3
26.00-28.00+                     2 -3                     2 -3                                         2 -3 2 -3      2 -3
24.00-26.00+                     2 -3                                                                                 2 -3 2 -3
22.00-24.00+                                                                                                               2 -3
20.00-22.00+                               3 -3
18.00-20.00+
16.00-18.00+
14.00-16.00+
12.00-14.00+           3 -3
10.00-12.00+                          3 -3
 8.00-10.00+                                                                                           2 -3
 6.00- 8.00+
 4.00- 6.00+                                                                                           2 -3      2 -3
 2.00- 4.00+
  .00- 2.00+                                                        3 -1
GAMMA (DEG)+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+

           1    1    1    1    1    1    2    2    2    2    2    2    2    2    2    2    3    3    3    3    3    3    3    3    3
           4    5    6    7    8    9    0    1    2    3    4    5    6    7    8    9    0    1    2    3    4    5    6    7    8
           .    .    .    .    .    .    .    .    .    .    .    .    .    .    .    .    .    .    .    .    .    .    .    .    .
           0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
           0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
```

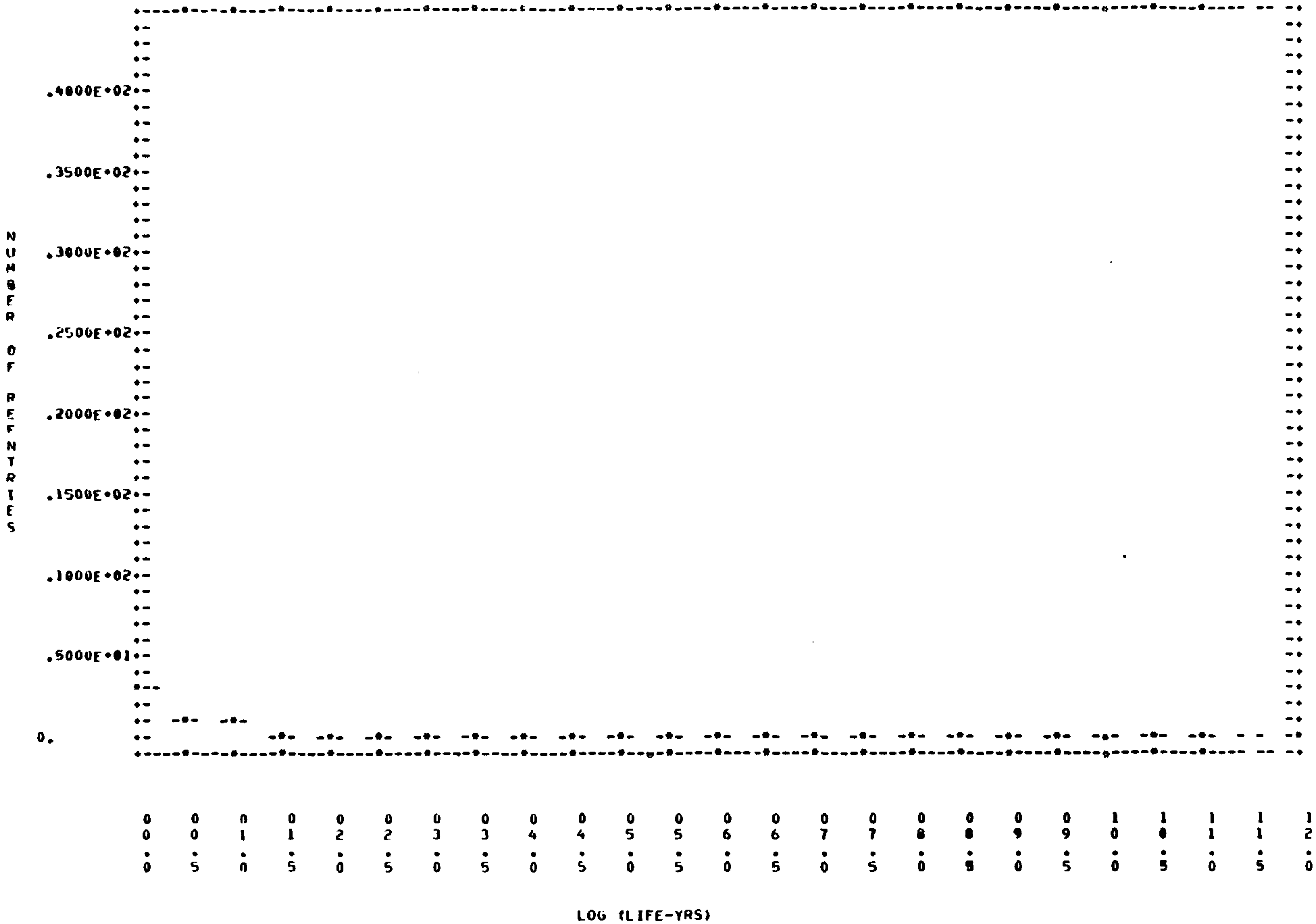
ENTRY SPEED (KILOFEET PER SECOND)

PROBABILITY OF ORBITAL DECAY TIMES   BALLISTIC COEF. .2592E+03KG/M**2

HOURS		DAYS		MONTHS		YEARS				CENTURIES	
1	0.	1	0.	1	0.	1	.67E-01	51	0.	1	0.
2	0.	2	0.	2	0.	2	.17E-02	52	0.	2	0.
3	0.	3	0.	3	0.	3	0.	53	0.	3	0.
4	0.	4	0.	4	.67E-01	4	.67E-01	54	0.	4	0.
5	0.	5	0.	5	0.	5	0.	55	0.	5	0.
6	0.	6	0.	6	0.	6	0.	56	0.	6	0.
7	0.	7	0.	7	0.	7	0.	57	0.	7	0.
8	0.	8	0.	8	0.	8	0.	58	0.	8	0.
9	0.	9	0.	9	0.	9	0.	59	0.	9	0.
10	0.	10	0.	10	0.	10	0.	60	0.	10	0.
11	0.	11	0.	11	0.	11	0.	61	0.	11	0.
12	0.	12	0.	12	0.	12	.67E-01	62	0.	12	0.
13	0.	13	0.			13	0.	63	0.	13	0.
14	0.	14	0.			14	0.	64	0.	14	0.
15	0.	15	0.			15	0.	65	0.	15	0.
16	0.	16	0.			16	0.	66	0.	16	0.
17	0.	17	0.			17	0.	67	0.	17	0.
18	0.	18	0.			18	0.	68	0.	18	0.
19	0.	19	0.			19	0.	69	0.	19	0.
20	0.	20	0.			20	0.	70	0.	20	0.
21	0.	21	0.			21	0.	71	0.	21	0.
22	0.	22	0.			22	0.	72	0.	22	0.
23	0.	23	0.			23	0.	73	0.	23	0.
24	0.	24	0.			24	0.	74	0.	24	0.
		25	0.			25	0.	75	0.	25	0.
		26	0.			26	0.	76	0.	26	0.
		27	0.			27	0.	77	0.	27	0.
		28	0.			28	0.	78	0.	28	0.
		29	0.			29	0.	79	0.	29	0.
		30	0.			30	0.	80	0.	30	0.
						31	0.	81	0.	31	0.
						32	0.	82	0.	32	0.
						33	0.	83	0.	33	0.
						34	0.	84	0.	34	0.
						35	0.	85	0.	35	0.
						36	0.	86	0.	36	0.
						37	0.	87	0.	37	0.
						38	0.	88	0.	38	0.
						39	0.	89	0.	39	0.
						40	0.	90	0.	40	0.
						41	0.	91	0.	41	0.
						42	0.	92	0.	42	0.
						43	0.	93	0.	43	0.
						44	0.	94	0.	44	0.
						45	0.	95	0.	45	0.
						46	0.	96	0.	46	0.
						47	0.	97	0.	47	0.
						48	0.	98	0.	48	0.
						49	0.	99	0.	49	0.
						50	0.	100	0.	50	0.
								GREATER THAN 50	0.		

NOTE---THE NUMBERS 1,2,3...48,49,50 REPRESENT THE INTERVALS 0-1,1-2,2-3,...47-48,48-49,49-50 RESPECTIVELY

TOTAL NUMBER OF REENTRIES ANALYZED 5



DATE
FILMED

7-8